TM 11-5556

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

SIGNAL GENERATOR SG-13/ARN

DEPARTMENT OF THE ARMY • SEPTEMBER 1956

TECHNICAL MANUAL)
NO. 11-5556)

DEPARTMENT OF THE ARMY
Washington 25, D. C., 27 September 1956

SIGNAL GENERATOR SG-13/ARN

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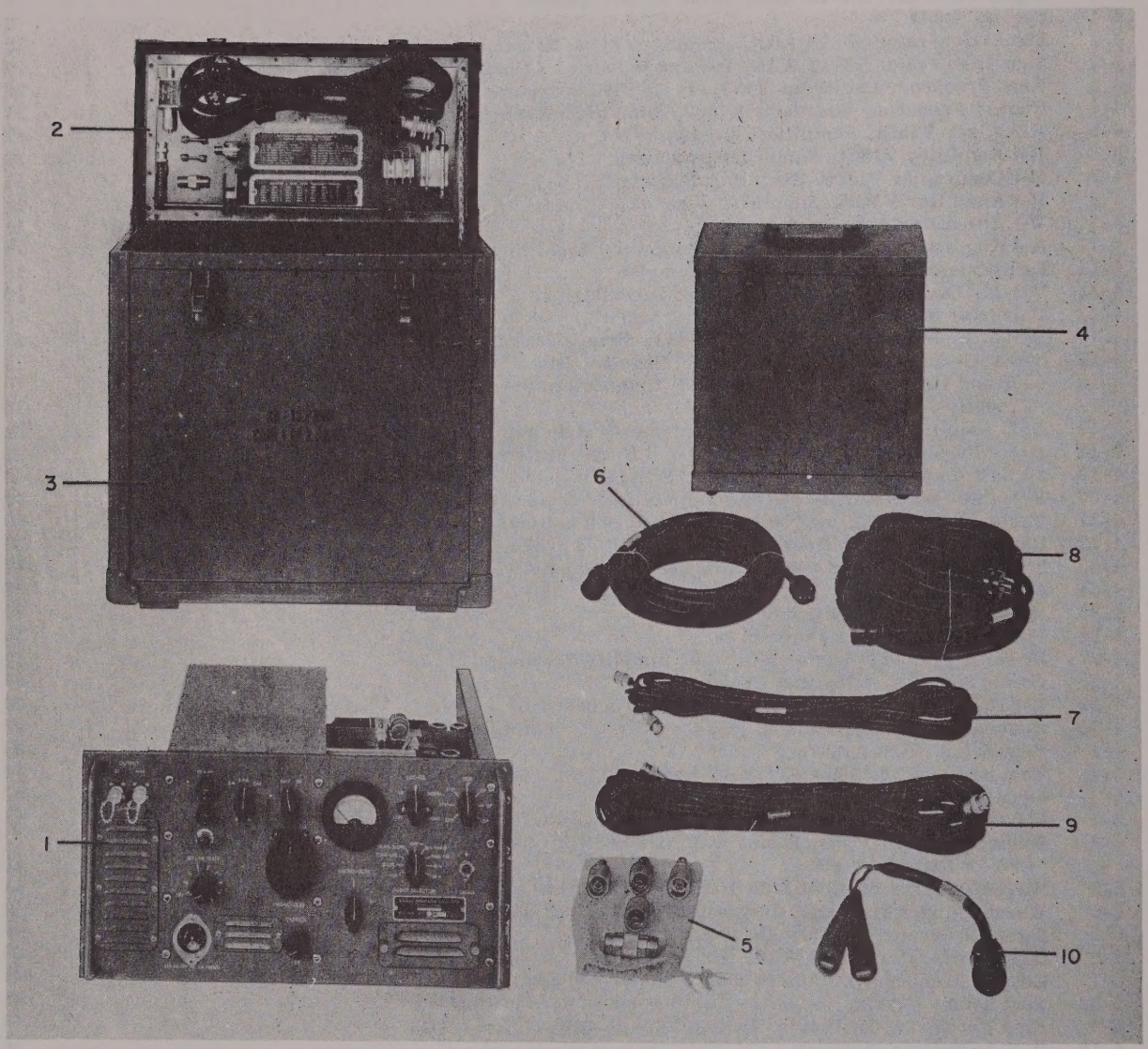


1 **Signal Generator SG-13/ARN**
2 Carrying case cover (See Figure 1-2)
3 Signal generator carrying case
4 Accessory Case CY-868/U
5 Adapter UG-29/U and four Adapters UG-201/U
6 Power Cable Assembly CX-1506/U (25 ft)
7 R-F Transmission Line CG-409A/U (25 ft)
8 Power Cable Assembly CX-1506/U (50 ft)
9 R-F Transmission Line CG-409A/U (50 ft)
10 Power Adapter CX-2489/U

Figure 1-1. Signal Generator SG-13/ARN

SECTION I

DESCRIPTION AND LEADING PARTICULARS

1-1. INTRODUCTION.

1-2. This handbook contains the theory of operation and maintenance of Signal Generator SG-13/ARN (figure 1-1).

1-3. PURPOSE.

1-4. The signal generator is a portable test instrument for ramp testing of aircraft navigation, localizer and glide slope receivers.

1-5. EQUIPMENT SUPPLIED.
(See figures 1-1 and 1-2.)

1-6. The signal generator is supplied in two cases. Case 1 contains all equipment necessary for operation within 10 feet of the receiver under test and the power source. Case 2 contains additional equipment necessary for operation within 85 feet of the receiver under test and the power source. Table I lists all equipment supplied as part of Signal Generator SG-13/ARN.

TABLE I. EQUIPMENT SUPPLIED

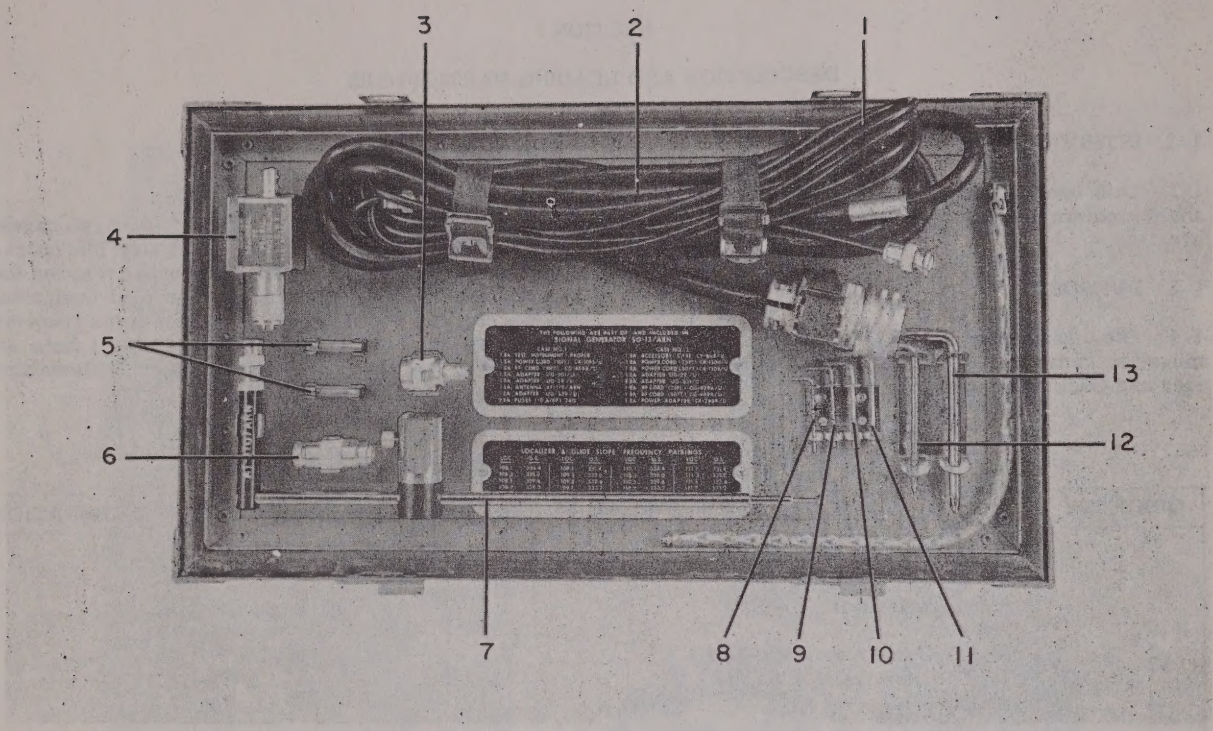
QUANTITY	NAME	GOVERNMENT TYPE DESIGNATION
	CASE 1	
1	Signal Generator	SG-13/ARN
1	Antenna	AT-170/ARN
1	Power Cable Assembly (10 ft)	CX-1095/U
1	R-F Transmission Line (10 ft)	CG-409A/U
1	Adapter	UG-201/U
1	Adapter	UG-29/U
1	Adapter (impedance matching)	UG-529/U
2	Fuse	3AG
1	Bristol Wrench #10	
1	Bristol Wrench #8	
1	Bristol Wrench #6	
1	Bristol Wrench #4	
1	Phillips Screwdriver #2	
1	Phillips Screwdriver #1	
	CASE 2	
1	Accessory Case	CY-868/U
1	Power Cable Assembly (25 ft)	CX-1506/U
1	Power Cable Assembly (50 ft)	CX-1506/U
1	Power Adapter	CX-2489/U
1	R-F Transmission Line (25 ft)	CG-409A/U
1	R-F Transmission Line (50 ft)	CG-409A/U
1	Adapter	UG-29/U
4	Adapter	UG-201/U

1-7. DESCRIPTION.

1-8. SIGNAL GENERATOR. The signal generator (figure 1-3) is mounted in a combination case having a waterproof snap-on cover (figure 1-2) that contains all accessories necessary for operation within 10 feet of the equipment under test. The signal generator is divided into two sections that have a common front panel.

a. The r-f section contains all the circuits necessary to produce the required r-f signals. It comprises a shielded r-f chassis, (2, figure 1-3) for producing r-f signals in 280 channels spaced at 100 kc intervals in the range of 108.0 to 135.9 megacycles and a shielded univerter chassis (1, figure 1-3) for producing r-f signals spaced at 100 kc intervals in the range of 329.3 to 335.0 megacycles for glide slope testing. The r-f chassis also contains a piston type attenuator allowing the r-f output to be varied from 4 to 200,000 microvolts.

b. The audio section (3, figure 1-3) contains all the circuits necessary to produce the required audio signals for modulating the r-f carrier and the power supply for the signal generator. An audio selector switch is used to select the type of modulating signal desired.



1 R-F Transmission Line CG-409A/U (10 ft)
2 Power Cable Assembly CX-1095/U (10 ft)
3 Adapter UG-201/U
4 Adapter UG-529/U (impedance matching)
5 Fuse 3AG
6 Adapter UG-29/U
7 Antenna AT-170/ARN
8 Bristol Wrench #4
9 Bristol Wrench #6
10 Bristol Wrench #8
11 Bristol Wrench #10
12 Phillips Screwdriver #1
13 Phillips Screwdriver #2

Figure 1-2. Signal Generator SG-13/ARN, Carrying Case Cover Showing Accessories

1-9. ACCESSORIES. The accessories are stored in the cover (figure 1-2) of the signal generator case (case 1) and in a separate Accessory Case CY-868/U (4, figure 1-1). They consist of power and r-f cables, antenna, adapters and tools.

a. Three power cables, 10, 25 and 50 feet long, allow operation of the signal generator within 85 feet of the power source. A power adapter is supplied for connection to a power source without an AN connector.

b. Three r-f cables, 10, 25 and 50 feet long, allow operation of the signal generator within 85 feet of the equipment under test.

c. The antenna is telescopic and is used for overall installation checks including the receiving antenna system.

d. Five Adapters UG-201/U are used, as required, to terminate the r-f cables when connected to a receiver or to each other. Two Adapters UG-29/U are used, as required, to connect the r-f cables together. Adapter UG-529/U is used to impedance match the signal generator to the receiver under test when the receiver has a 95 ohm balanced input.

e. Four Bristol wrenches and two Phillips screwdrivers are mounted on the signal generator case cover for use in disassembling the equipment.

1-10. PRINCIPLES OF OPERATION.

1-11. R-F SECTION. The r-f section supplies the r-f carrier by mixing the outputs of two crystal controlled oscillators and multiplying the sum frequency to the desired 108.0- to 135.9-mc output frequency for testing navigation and localizer receivers. When testing glide slope receivers, a frequency range 329.3 to 335.0 mc is required. These frequencies are produced by mixing the output of the r-f chassis with the output of a 200-mc oscillator in the univerter chassis.

1-12. AUDIO SECTION. The audio section generates the various audio signals required for modulating the r-f carrier. Stable RC oscillators produce audio frequencies of 30 cps, 9960 cps and 1000 cps. By distorting the 30-cps signal and selecting the third and fifth harmonies, 90 cps and 150 cps are produced.

1-13. POWER SUPPLY. The power supply is a 21-volt dynamotor which furnishes unregulated +230 volts and regulated +150 volts for use by all the signal generator circuits.

1-14. LEADING PARTICULARS.

1-15. FREQUENCY RANGES AND STABILITY.

a. 108.0 to 135.9 mc in 100 kc steps (280 channels).

b. 329.3 to 335.0 mc in 100 kc steps (58 channels).

c. Stability of r-f output: ±0.0065%.

1-16. OUTPUT RANGE. 4 to 200,000 microvolts.

1-17. AUDIO SIGNALS.

a. Omni-range (VOR): 30 cps variable phase and 9960 cps frequency modulated at 30 cps.

b. Phase localizer (ϕ LOC): 30 cps reversible phase and 9960 cps frequency modulated at 30 cps.

c. Tone localizer (TONE LOC): 90 cps and 150 cps sine waves.

d. Glide slope (GS): 90 cps and 150 cps sine waves.

e. 1000 cps sine wave.

f. 30 cps variable phase.

g. 9960 cps frequency modulated at 30 cps.

h. 90 cps sine wave.

i. 150 cps sine wave.

1-18. POWER REQUIREMENTS. 21 to 29 volts dc at 5.4 amperes.

1-19. COMPONENT WEIGHTS.

a. Signal generator case and accessories (Case 1): 45 lbs.

b. Accessory Case CY-868/U (Case 2): 15 lbs.

1-20. DYNAMOTOR DATA.

Manufacturer: Eicor Incorporated

Type No: ML-2711-1

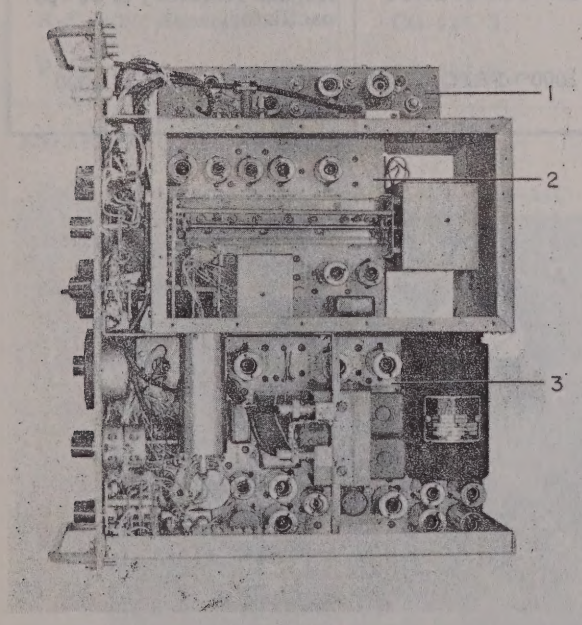
Input: 21 volts dc at 3.3 amperes.

Output: 260 volts dc at 0.135 ampere.

Temperature rise: Not to exceed 40° C (104° F) above 55° C (131° F).

1-21. FUSE COMPLEMENT. One 25-volt, 10-ampere fuse in each side of line.

1-22. TUBE COMPLEMENT. Table II lists all tubes and their functions in Signal Generator SG-13/ARN.



1 Univerter chassis
2 R-f chassis
3 Audio chassis

Figure 1-3. Signal Generator SG-13/ARN, Chassis Layout

TABLE II. TUBE COMPLEMENT

SYMBOL NUMBER	TUBE TYPE	FUNCTION
		AUDIO CHASSIS
V1401A	1/2 5814	Cathode follower
V1401B	1/2 5814	30 cps oscillator
V1402A,B	5814	
V1403A,B	5814	30 cps amplifier
V1404A,B	12AX7	150 cps limiter
V1405A,B	12AX7	90 cps limiter
V1406	6AG5	9960 and 1000 cps oscillator
V1407A	1/2 12AX7	Cathode follower
V1407B	1/2 12AX7	Frequency modulator
V1408A	1/2 5814	Afc amplifier
V1408B	1/2 5814	A-f amplifier
V1409A,B	6AL5W	Discriminator
V1410	0A2	Voltage regulator
V1411	0A2	Voltage regulator
V1412	0A2	Voltage regulator

TABLE II. TUBE COMPLEMENT (Cont)

SYMBOL NUMBER	TUBE TYPE	FUNCTION
		R-F CHASSIS
V1501A,B	5670	Fine frequency oscillator
V1502	6AK5W	Coarse frequency oscillator
V1503	6AK5W	R-f mixer
V1504	6AK5W	R-f amplifier
V1505	6AK5W	R-f quadrupler
V1506	6AK5W	R-f amplifier
V1507	6AK5W	A-f amplifier
V1508	6AQ5	Modulator
V1509A,B	5751	Demodulator
		UNIVERTER CHASSIS
V1510A,B	12AT7	200 mc oscillator
V1511	6AK5W	Univerter mixer
V1512	6AK5W	Univerter amplifier
V1513	6AK5W	Univerter amplifier

1-23. OPERATING CONTROLS AND ADJUSTMENTS. The operating controls and adjustments are listed with their functions in table III and shown in figure 1-4.

TABLE III. OPERATING CONTROLS AND ADJUSTMENTS

CONTROL	FUNCTION
SET LINE TO 21V	Power on-off switch and d-c input voltage control.
CARRIER SET	Adjusts audio signal that modulates the r-f carrier for calibration of MICROVOLTS control.
METER	Selects the meter function.
MICROVOLTS	Calibrated from 4 to 200,000 microvolts for r-f output control.
MEGACYCLES	Adjusts the signal generator frequency.
NAV-GS	Selects r-f frequency range.
AUDIO SELECTOR	Selects audio signal for modulating the r-f carrier.
VOR	Phase shifts the 30 cps component of the VOR signal.
±1 DEGREE	Phase shifts the 30 cps component of the VOR signal one degree in either direction.
LOC-GS	Varies the ratio of 90 and 150 cps tone localizer and glide slope signals.
METER ZERO	Sets the meter to zero.
30∿FREQUENCY	Adjusts frequency of 30 cps oscillator.
1000∿FREQUENCY	Adjusts frequency of 1000 cps oscillator.

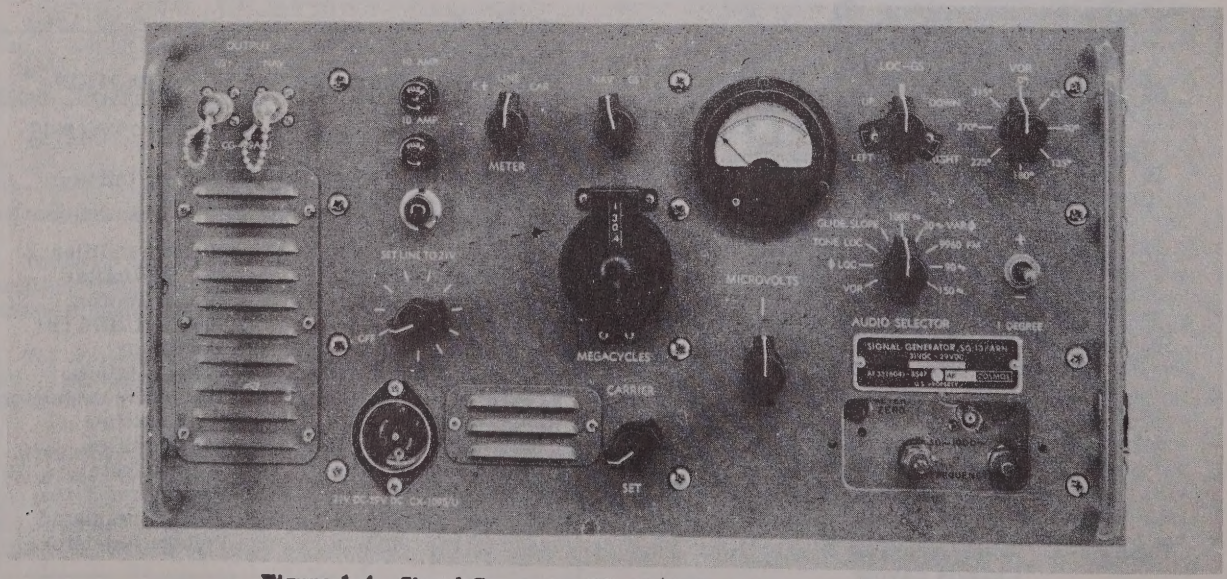


Figure 1-4. Signal Generator SG-13/ARN, Front Panel Controls

SECTION II

SPECIAL TEST EQUIPMENT AND TOOLS

2-1. SPECIAL TEST EQUIPMENT.

2-2. The test equipment necessary to test and align Signal Generator SG-13/ARN is listed in tables IV and V below.

TABLE IV. TEST EQUIPMENT (SPECIFIC TYPES)

NAME	AN DESIGNATION	ALTERNATE	APPLICATION
SIGNAL GENERATOR	SG-1/ARN	None	Signal source for NAV frequencies.
Power Supply	PP-348/ARN		Power for SG-1/ARN
Power Cord	CX-237/U		PP-348/ARN line cord.
Power Cable Assembly	CX-1290/ARN		Power connector.
R-F Cable Assembly	CG-409/U		SG-1/ARN r-f output cable.
Adapter Connector	UG-528/U		6-db pad and adapter for CG-409/U to R-540A/ ARN-14C.
MODULATOR	MD-83A/ARN	None	Audio modulation for SG-1/ARN.
R-F Cable Assembly	CG-530/U		Connector to SG-1/ARN.
Power Cord	CX-237/U		Power line cord.
AN/ARN-14 COMPONENTS			
Radio Receiver	R-540/ARN-14C	R-252A/ARN-14	Comparative measurements.
Dynamotor	DY-66B/ARN-14C	DY-66A/ARN-14	Power for receiver.
Course Indicator	ID-249A/ARN		Crosspointer and TO-FROM indications.
Control Panel	C-760B/A	C-760/A	Receiver control.
SIGNAL GENERATOR	SG-2/GRM-4	None	Signal source for GS frequencies.
Power Cord	CX-237/U		Power line cord.
R-F Cable Assembly	CG-409/U		R-f output cable.
Adapter Connector	UG-528/U		6-db pad and adapter for CG-409A/U to R-322/ ARN-18.
AN/ARN-18 COMPONENTS			
Radio Receiver	R-322/ARN-18		Comparative measurements.

TABLE IV. TEST EQUIPMENT (SPECIFIC TYPES) (Cont)

NAME	AN DESIGNATION	ALTERNATE	APPLICATION
BALLANTINE MODEL 300 ELECTRONIC VOLTMETER			Comparative a-c voltage measurements.
WESTON MODEL 901 MICROAMMETER			Measure receiver cross-pointer current.

TABLE V. TEST EQUIPMENT (GENERAL TYPES)

NAME	REQUIRED CHARACTERISTICS
D-C Vacuum Tube Voltmeter	D-c voltmeter, ohmmeter. Input impedance: 10 megohms. Ranges: 3 to 5 volts full scale and three higher ranges to 300 volts.
Oscilloscope	Input impedance: 2 megohms or more, 25uuf or less. Uniform frequency characteristic from 20 to 20,000 cps.
Audio Oscillator	Frequency range: 20 to 15,000 cps. Output: 1 volt.
Frequency Meter	Secondary frequency standard: ±0.001% Range: 5000 to 10,000 kc.

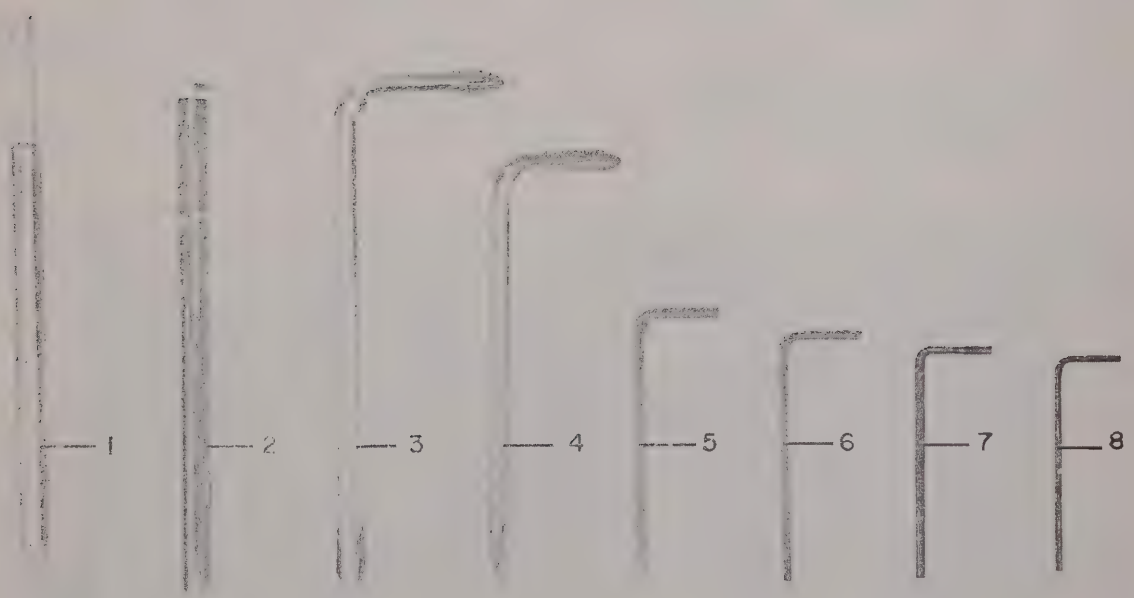


Figure 2-1. Special Tools

2-3. SPECIAL TOOLS.

2-4. The special tools required to perform maintenance, alignment and overhaul operations on Signal Generator SG-13/ARN are listed in table VI and shown in figure 2-1.

TABLE VI. SPECIAL TOOLS

FIG. 2-1 INDEX NO.	PART NUMBER	NAME	APPLICATION
1	802-M-35027	Tuning wand	For adjusting C1529 and checking the tuning of T1501, T1502, Z1501 and Z1502.
2	802-M-35019	Alignment tool	For adjusting T1501, T1502 and Z1501 and trimmer capacitors.
3	Comm	Phillips screwdriver #2	For screw sizes 5 thru 10.
4	Comm	Phillips screwdriver #1	For screw sizes up thru 4.
5	Comm	Bristol wrench #10	For No. 10 set screws.
6	Comm	Bristol wrench #8	For No. 8 set screws.
7	Comm	Bristol wrench #6	For No. 6 set screws.
8	Comm	Bristol wrench #4	For No. 4 set screws.

SECTION III

PREPARATION FOR USE AND RESHIPMENT

3-1. PREPARATION FOR USE.

3-2. Remove the crating from each case and examine the equipment for damage that may have occurred during shipment. Check the contents of each case against table I.

3-3. PREPARATION FOR SHIPMENT OR STORAGE.

3-4. Prepare the equipment for shipment or storage as follows:

a. Coil the two 25-foot and the two 50-foot cables and with the power adapter, place them in case 2.

b. Place four Adapters UG-201/U and one Adapter UG-29/U into the mailing bag and place the bag in case 2.

c. Close the cover of case 2 and lock the two catches.

d. Coil the two 10-foot cables, place them on the cover of case 1 and tighten the two straps.

e. Replace the remaining accessories on the cover and check that they are properly mounted in their clamps. See figure 1-2 for the location of accessories on the cover.

f. Replace the cover of case 1 and lock the two catches.

SECTION IV

THEORY OF OPERATION

4-1. GENERAL SYSTEM OPERATION.

4-2. Signal Generator SG-13/ARN consists of an r-f chassis, a univerter chassis, and an audio chassis which includes the power supply. Figure 4-1 is a simplified block diagram of the signal generator.

a. The r-f chassis supplies the r-f carrier by mixing the outputs of two crystal-controlled oscillators and multiplying the sum frequency to the desired output frequency of 108.0 to 135.9 mc for testing navigation and localizer receivers (NAV operation).

b. When testing glide slope receivers a frequency range of 329.3 to 335.0 mc is required. For glide slope operation the output of the r-f chassis is delivered to the univerter chassis where it is mixed with a 200-mc oscillator. The sum frequency of 329.3 to 335.0 mc is then delivered to the GS OUTPUT jack.

c. The audio chassis generates the various audio signals required for modulating the r-f carrier. Stable RC oscillators produce audio frequencies of 30 cps, 9960 cps and 1000 cps. By distorting the 30-cps signal and selecting the third and fifth harmonics, 90 cps and 150 cps are also produced. The audio signal is delivered to the r-f chassis where it modulates the r-f carrier.

d. The power supply is mounted on the audio chassis and is a 21-volt dynamotor which furnishes unregulated 230 volts and regulated 150 volts for use by all the signal generator circuits.

4-3. FUNCTIONAL OPERATION OF ELECTRONIC COMPONENTS.

4-4. R-F CHASSIS.

4-5. INTRODUCTION. The r-f chassis (figure 4-2) supplies the r-f carrier during NAV operation. The output frequency of 108.0 to 135.9 mc is developed by first mixing the output of crystal-controlled fine frequency oscillator V1501 (4.875 to 5.100 mc) with the output of crystal-controlled coarse frequency oscillator V1502 (22.125 to 28.875 mc). Oscillator V1502 uses the third harmonic of the selected crystal. The output of V1501 and V1502 is fed to r-f mixer V1503 where the sum frequency (27.000 to 33.975 mc) is selected and all other frequencies are rejected. This frequency is amplified by r-f amplifier V1504 and fed to r-f quadrupler V1505. The fourth harmonic (108.0 to 135.9 mc) is taken from V1505 and delivered to r-f amplifier V1506. R-f Amplifier V1506 also receives the selected audio signal from the audio chassis. It is amplified by a-f amplifier V1507 and fed to V1506 through modulator V1508. The r-f carrier is modulated by the selected audio signal and fed to r-f attenuator Z1502 where the desired amount of attenuation occurs depending on the setting of the MICROVOLTS control. The attenuated and modulated carrier frequency is fed through coaxial relay K1401 to NAV OUTPUT jack during NAV operation and to the univerter chassis for GS operation. A portion of the modulated carrier is fed to demodulator V1509, whose d-c output is proportional to the r-f signal amplitude,

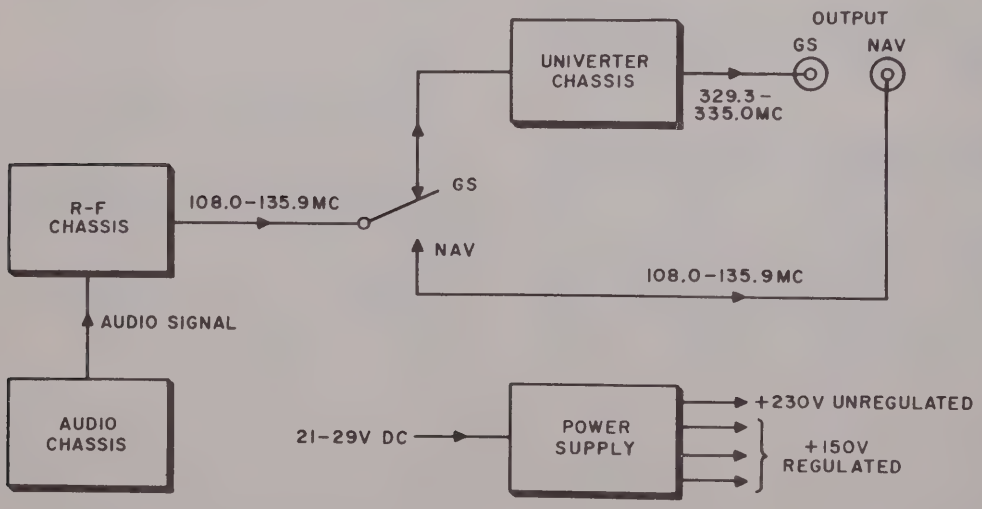


Figure 4-1. Signal Generator SG-13/ARN, Simplified Block Diagram

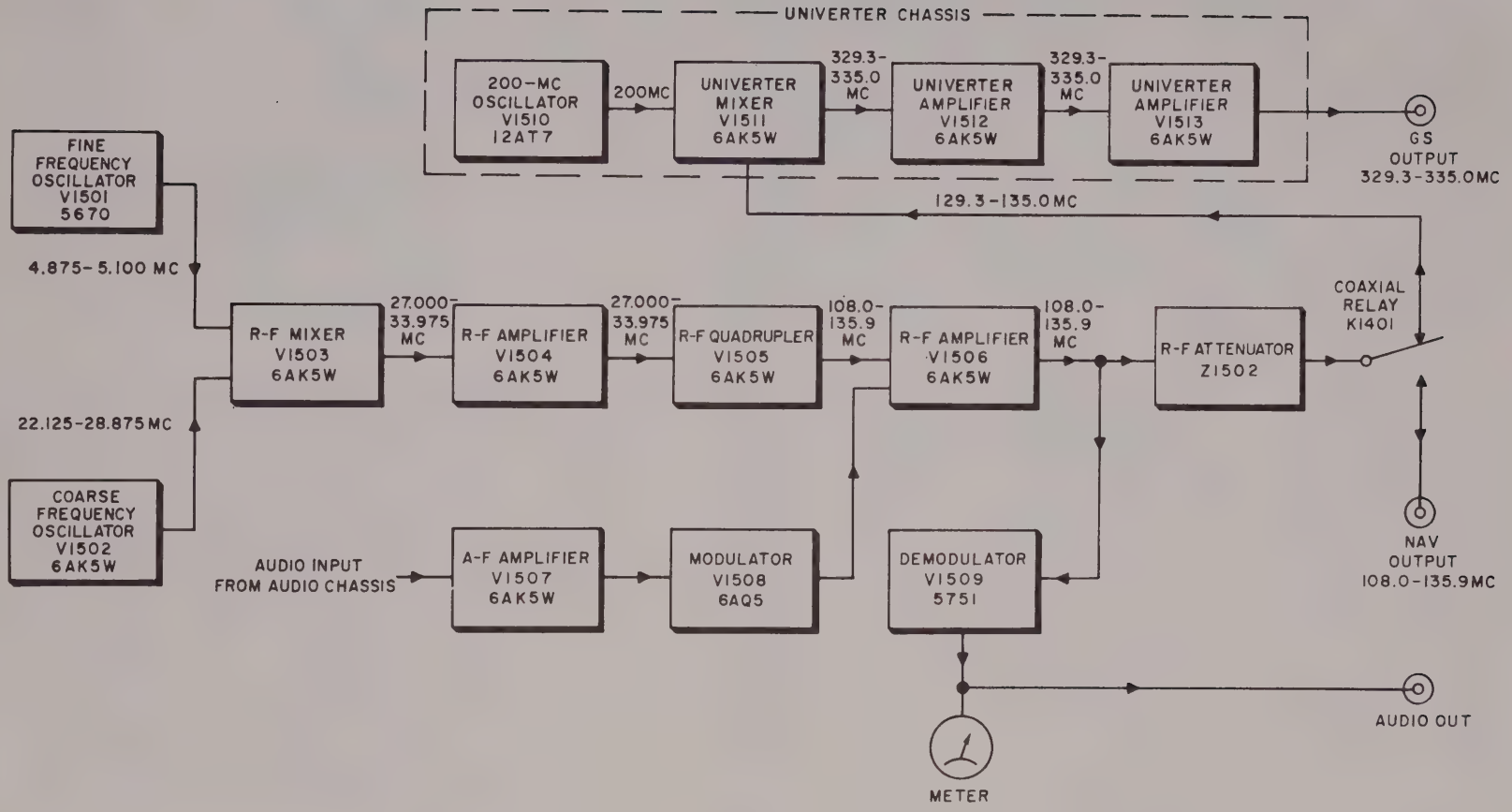


Figure 4-2. Signal Generator SG-13/ARN, R-f and Univerter Chassis, Block Diagram

for use in calibrating the MICROVOLTS control. The audio signals obtained from the demodulator appear at AUDIO OUT jack on the front panel for test purposes. The r-f chassis is contained in an aluminum shield which is insulated from the front panel and audio chassis as well as from the r-f chassis. This is necessary to minimize r-f leakage and is broken only at a few carefully selected points. All audio and power leads are brought out of the r-f chassis through a filter assembly to prevent radiation from the unit on the external leads.

4-6. FINE FREQUENCY OSCILLATOR V1501. (See figure 4-3.)

4-7. Fine frequency oscillator V1501 is a crystal-controlled oscillator using a twin triode with one section, V1501B, connected as a Colpitts oscillator while the other section, V1501A, is a cathode follower acting as a buffer stage. The inner knob of MEGACYCLES control S1501 selects the crystal required giving the oscillator a frequency range of 4.875 to 5.100 mc in 10 steps of 25 kc each.

NOTE

The inner knob will vary the signal generator frequency in steps of 100 kc due to the quadrupling of the r-f signal by r-f quadrupler V1505.

4-8. The oscillator output is taken from the tuned grid circuit of V1501B and fed through coupling capacitor C1503 to the grid of cathode follower V1501A. The cathode follower acts as a buffer stage isolating the oscillator from the other circuits in the r-f chassis. The plate circuits of V1501A and B contain decoupling filters which prevent r-f from entering the power supply. The output is taken from the cathode of V1501A and delivered to r-f mixer V1503.

4-9. COARSE FREQUENCY OSCILLATOR V1502. (See figure 4-4.)

4-10. Coarse frequency oscillator V1502 is a crystal-controlled oscillator connected as a Colpitts oscillator. The outer knob of the MEGACYCLES control selects the required crystal, whose third harmonic is used, giving the oscillator a frequency range of 22.125 to 28.875 mc in 28 steps of 250 kc each.

4-11. The coarse frequency oscillator crystals are arranged in two banks, one containing crystals for odd MEGACYCLES positions, the other containing crystals for even MEGACYCLES position. Turning the large outer knob of the MEGACYCLES control rotates a shaft that controls S1502A and S1502B and selects a cr. .al in one bank or the other depending on whether the selected megacycle frequency is od d or even. This is accomplished by S1503, on the same shaft as S1502, which connects 21 volts dc to relay K1501 on odd MEGACYCLES positions. When K1501 is energized, its contacts 2 and 3 close connecting a crystal from the bank switched by S1502A to the grid circuit of V1502. On even MEGACYCLES positions, K1501 is not energized and its contacts 3 and 4 close, connecting a crystal from the bank switched by S1502B to V1502. Tuning the large outer knob also operates a slug rack which varies the tuning of seven coils, L1510, L1511, L1503, L1504, L1505, L1506 and

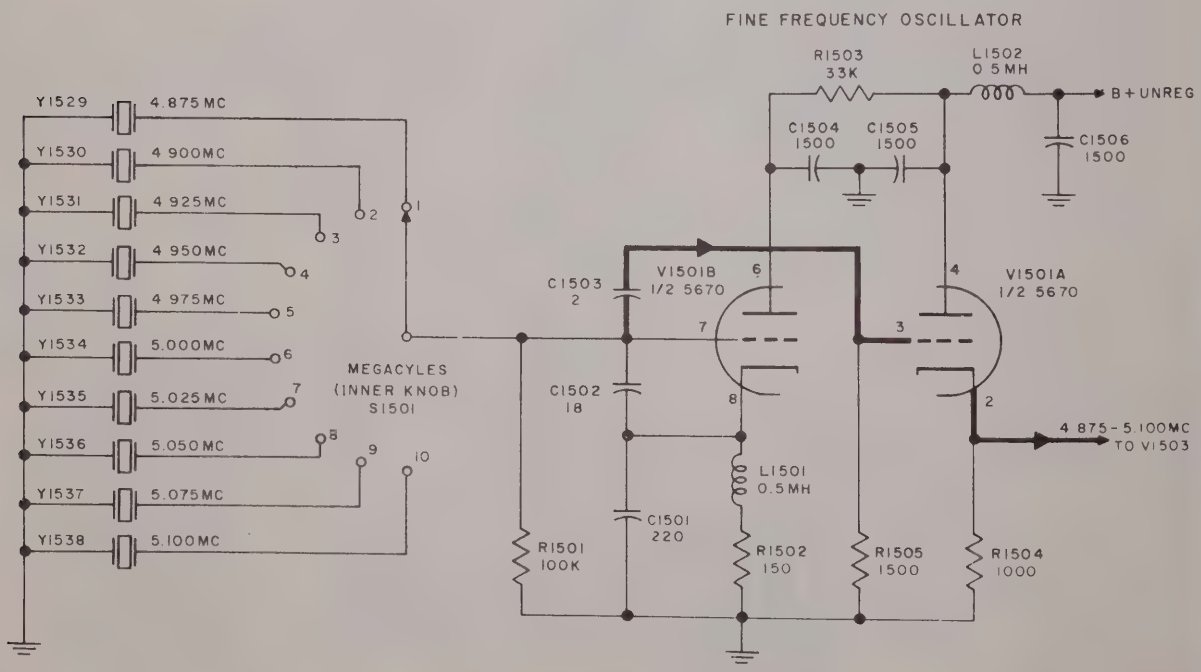


Figure 4-3. Fine Frequency Oscillator V1501, Simplified Schematic

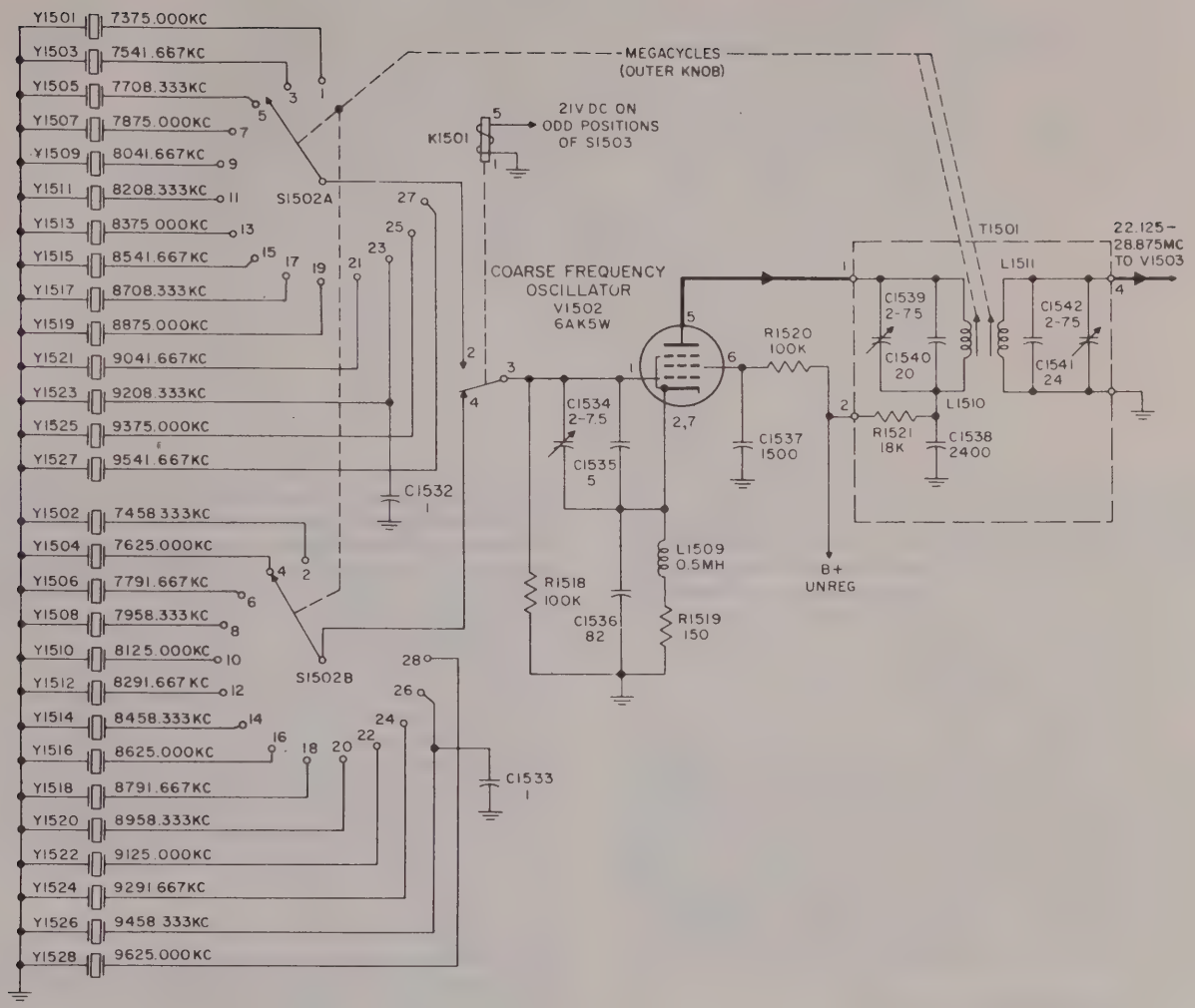


Figure 4-4. Coarse Frequency Oscillator V1502, Simplified Schematic

L1508, in the r-f chassis. Powdered iron cores, fastened to the slug rack, are moved in or out of the r-f coils in steps of approximately .015 inch for each megacycle change in the setting of the outer knob. Thus the tuning of L1506 and L1508 is automatically varied in approximately one-megacycle steps and L1503, L1504, L1505, L1510 and L1511 in approximately 250-kc steps to maintain proper tracking as the signal generator frequency is varied in one-megacycle steps.

NOTE

The band pass of the following tuned r-f stages is sufficiently wide so that no retuning of the slug rack is necessary over the megacycle spread represented by the fine frequency oscillator V1501.

4-12. The third harmonic of the selected crystal, 22.125 mc, is passed by the tuned circuit T1501 which will reject all other frequencies. The output from T1501 is fed to r-f mixer V1503. Trimmer capacitor C1534 adjusts the frequency of the coarse frequency oscillator for all 28 crystals. Trimmers C1539 and C1542 are used to adjust T1501 at the upper frequency limit.

4-13. R-F MIXER V1503.
(See figure 4-5.)

4-14. R-f mixer V1503 receives the output signals of the fine and coarse frequency oscillators V1501 and V1502. The output of V1501, 4.875 to 5.100 mc in 10 steps of 25 kc each, is coupled through C1507 and fed to the grid of r-f mixer V1503. The output of V1502, 22.125 to 28.875 mc in 28 steps of 250 kc each, is coupled through C1508 to the grid of V1503. The two

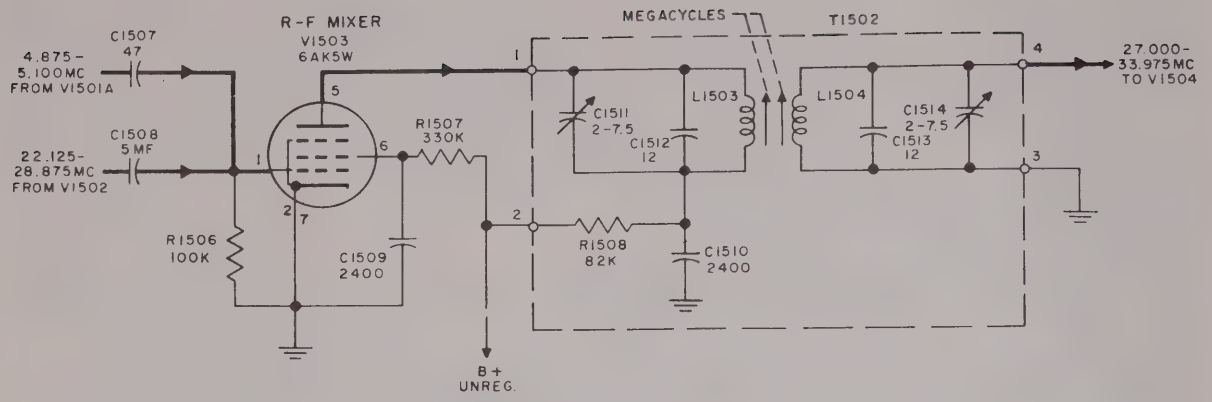


Figure 4-5. R-f Mixer V1503, Simplified Schematic

signals are mixed and the sum frequency, 27.000 to 33.975 mc, is passed through T1502 and fed to r-f amplifier V1504. Coils L1503 and L1504 are tuned in 28 steps of 250 kc each by the outer knob of the MEGACYCLES control. The band pass of T1502 is sufficiently wide to cover the megacycle spread of V1501. Trimmers C1511 and C1514 are used to adjust T1501 at the upper frequency limit.

4-15. R-F AMPLIFIER V1504.
(See figure 4-6.)

4-16. The 27.000 to 33.975-mc signal from V1503 is coupled through C1515 to the grid of r-f amplifier V1504. Here the signal is amplified and delivered to r-f quadrupler V1505. Part of Z1501, comprising L1505, C1519 and C1518, forms a tuned circuit that will pass a frequency in the range of 27.000 to 33.975 mc depending on the setting of the MEGACYCLES control. The band pass of this tuned circuit is sufficiently wide to cover the megacycle spread of V1501.

4-17. R-F QUADRUPLER V1505.
(See figure 4-7.)

4-18. The 27.000 to 33.975-mc signal from V1504 is coupled through C1520 to the grid of r-f quadrupler V1505. The signal is amplified and distorted by V1505 and due to the distortion of this signal, a signal rich in harmonics appears in the output. The plate circuit of V1505 is tuned to the fourth harmonic of the input signal by part of Z1501, a tuned circuit comprising L1506, C1523 and C1524, and the frequency of the output will be in the range of 108.0 to 135.9 mc. This output is fed to r-f amplifier V1506. Coil L1501 is tuned in 28 steps of one megacycle each by the outer knob of the MEGACYCLES control. The band pass of the tuned circuit is sufficiently wide to cover the megacycle spread of V1501. Trimmer C1523 is used to adjust the tuned circuit at the upper frequency limit.

4-19. R-F AMPLIFIER V1506.
(See figure 4-8.)

4-20. R-f amplifier V1506 is the output stage of the r-f chassis. The 108.0 to 135.9-mc signal from V1505 is coupled through C1525 and grid current limiting resistor R1566 to the control grid of V1506.

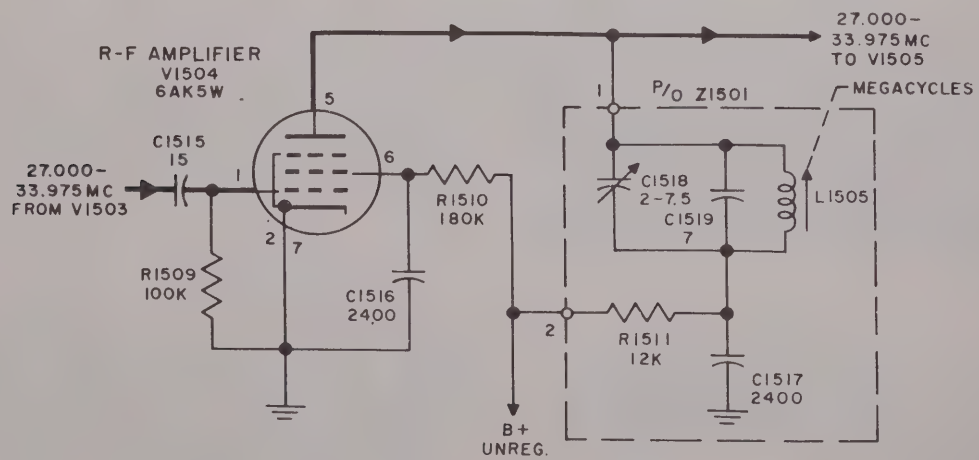


Figure 4-6. R-f Amplifier V1504, Simplified Schematic

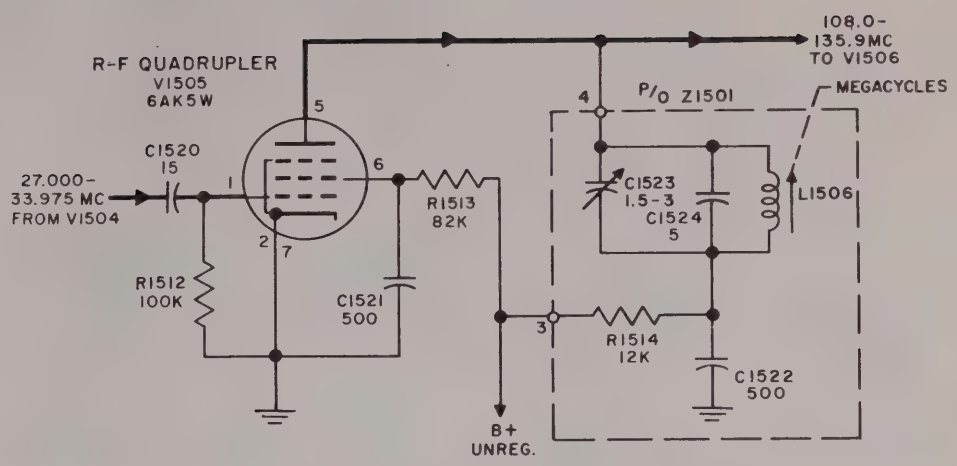


Figure 4-7. R-f Quadrupler V1505, Simplified Schematic

The audio signal from modulator V1508 is coupled directly to the screen grid of V1506. The r-f carrier is therefore modulated by the audio signal due to the audio variations appearing on the screen grid. The amplified and modulated output appears across the plate load L1507 and is coupled through C1528 to the output tuned circuit Z1502. A portion of the modulated carrier is fed to demodulator V1509 for calibration and test purposes. Z1502 is tuned in 28 steps of one megacycle each in the frequency range of 108.0 to 135.9 mc depending on the setting of the outer knob of the MEGACYCLES control which varies the position of the tuning slug of L1508. The band pass of Z1502 is sufficiently wide to cover the megacycle spread of V1501. Trimmer C1529 is used to adjust the tuned circuit at the upper frequency limit.

4-21. Terminal stud E1508 in the control grid circuit of V1506 is used as a voltage measuring point when aligning the r-f chassis. The measured voltage is developed across R1515. Bypass capacitor C1526 bypasses rf around the voltmeter that is connected to E1508 during r-f alignment.

4-22. The modulated r-f signal developed across Z1502 is coupled to NAV OUTPUT jack J1406 during NAV operation. During GS operation the modulated r-f carrier is delivered to the univerter chassis. Coupling is accomplished through a piston type r-f attenuator (figure 4-9) that is mounted in such a fashion that a small single-turn pickup loop (4, figure 4-9) may be moved with respect to the final output coil L1508 (2, figure 4-9) to vary the coupling and thus the r-f output. The motion of the piston and loop is produced by a rack and pinion drive mechanism controlled by the calibrated MICROVOLTS control. An inspection hole (5, figure 4-9) in the housing allows for checking the position of the loop (6, figure 4-9).

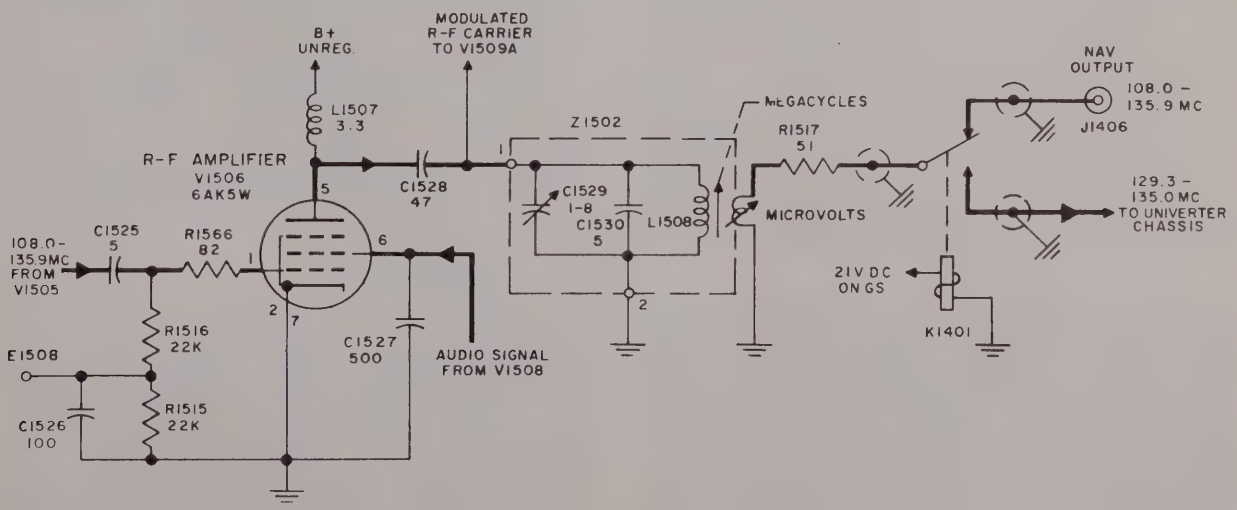
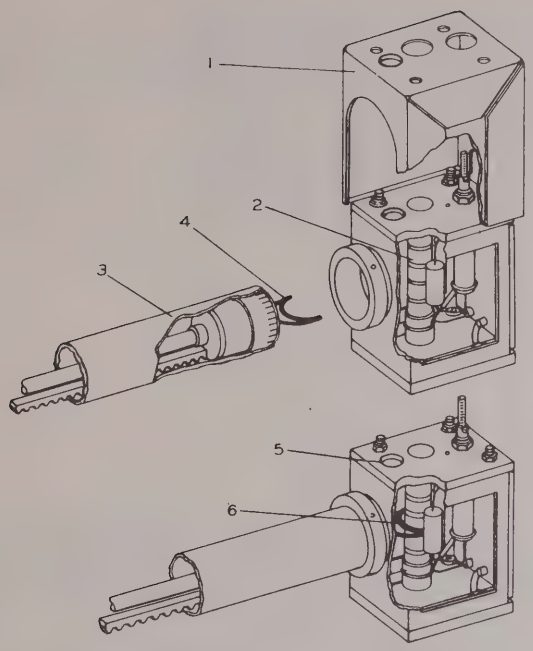


Figure 4-8. R-f Amplifier V1506, Simplified Schematic



1 Shield can for Z1502 assembly
2 Final r-f tank coil L1508
3 Attenuator removed from collar
4 Pick up loop
5 Inspection hole
6 Point of normal 1/32 to 3/64 inch clearance with MICROVOLTS set to maximum

Figure 4-9. R-f Attenuator Assembly

4-23. One end of the pickup loop is at ground potential. The other end of the pickup loop is connected through impedance matching resistor R1517, located in the piston, to the r-f output cable. The output cable is in turn connected to the movable contact of coaxial relay K1401, located on the audio chassis. With the NAV-GS switch in the NAV position, the r-f output is connected to NAV OUTPUT jack J1406 which now has an output impedance of 53 ohms. With the NAV-GS switch in the GS position, K1401 is energized and the r-f attenuator output is connected to the univerter chassis. The univerter chassis has unity gain with the same output impedance as the r-f chassis. Therefore, only the output frequency is changed during GS operation.

4-24. The NAV and GS output circuits are designed for direct connection to receivers having an unbalanced input circuit of approximately 53 ohms impedance to match the output impedance of the signal generator. Under these conditions, the MICROVOLTS dial will be direct reading. For testing receivers having a 95-ohm balanced input, Adapter UG-529/U is connected between the OUTPUT jack and the receiver input, matching the impedance of the two units. The adapter also has the effect of a 6-db attenuator pad because it reduces the effective r-f output of the signal generator by one-half. Under these conditions, the MICROVOLTS dial reads twice the actual r-f output. For example, to set up a 2000-microvolt signal, the MICROVOLTS dial must be set to 4000.

4-25. A-F AMPLIFIER V1507 AND MODULATOR V1508.
(See figure 4-10.)

4-26. A-f amplifier V1507 receives one of nine audio signals from the audio chassis as determined by the audio chassis as determined by the setting of the AUDIO SELECTOR switch. These audio signals are as follows:

a. 30 cps variable phase and 9960 cps, frequency modulated at 30 cps.

b. 30 cps reversible phase and 9960 cps, frequency modulated at 30 cps.

c. 90 cps and 150 cps sine waves.

d. 1000 cps sine wave.

e. 30 cps reversible phase.

f. 9960 cps, frequency modulated at 30 cps.

g. 90 cps sine wave.

h. 150 cps sine wave.

4-27. The selected audio signal is delivered to the control grid of V1507 through an r-f filter (part of the filter assembly) that prevents rf from radiating on the external leads of the r-f chassis. The audio signal is amplified by V1507 and coupled through C1543 to the control grid of modulator V1508.

4-28. Modulator V1508 is a cathode follower used as a power amplifier to supply adequate drive to the screen grid of modulator V1505 with a minimum of distortion to the audio signal. A fixed positive bias is applied to the control grid by tapping off a voltage divider, comprising R1528 and R1529, across the B+ supply. The output is taken from CARRIER SET control R1531 in the cathode circuit of V1508. This control adjusts the amplitude of audio signal that modulates the r-f carrier. A switch in series with the movable arm of R1531 allows the audio signal to be disconnected from the output r-f amplifier.

4-29. DEMODULATOR V1509.
(See figure 4-11.)

4-30. A portion of the modulated r-f carrier from the output of r-f amplifier V1506 is coupled through C1531 to the grid of V1509A. This section of the demodulator is an infinite impedance detector with a high input impedance and a high fidelity output. This prevents loading of the r-f output circuit and gives a d-c voltage output proportional to the input r-f voltage. This d-c voltage is coupled directly to V1509B which is connected as a cathode follower. The d-c output of

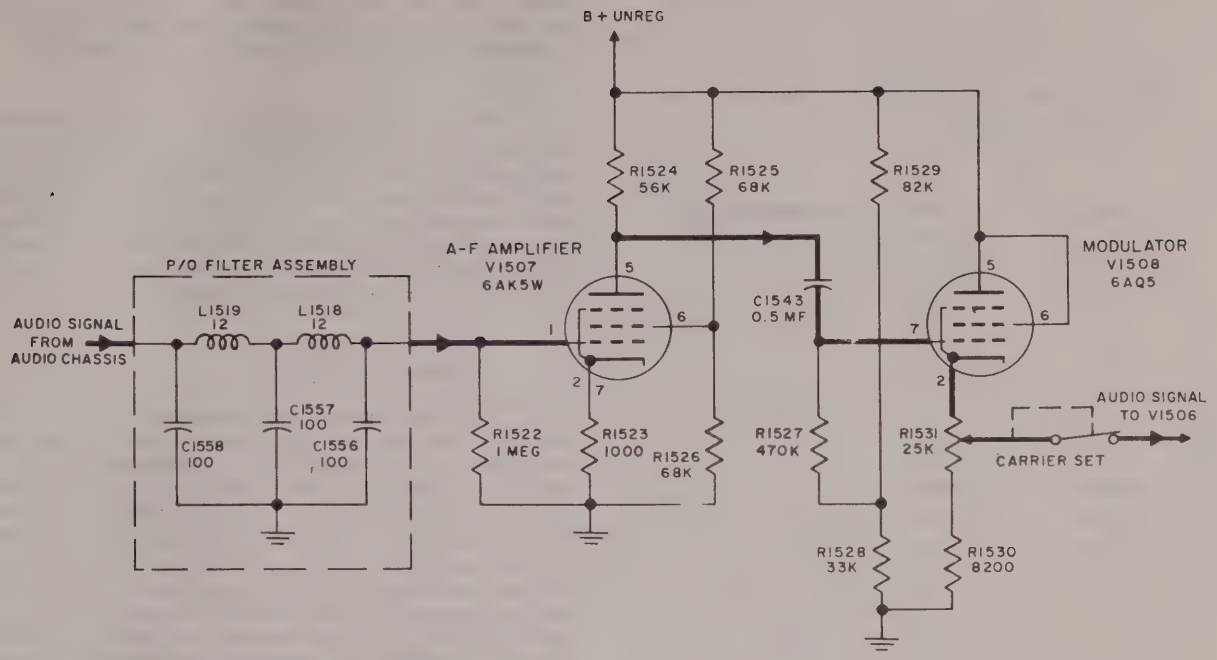
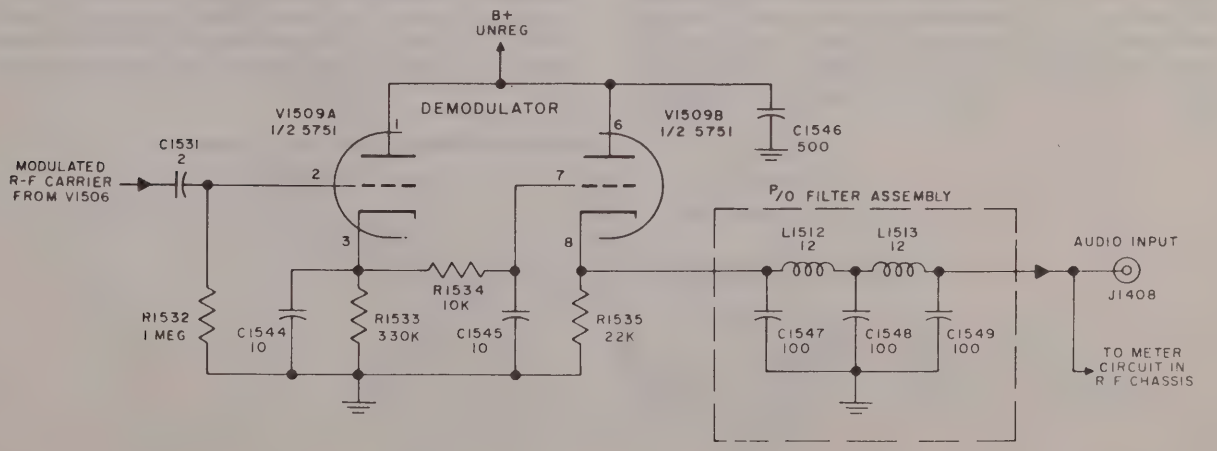


Figure 4-10. A-f Amplifier V1507 and Cathode Follower V1508, Simplified Schematic

the cathode follower, still proportional to the r-f input to V1509A, is coupled to the meter circuit and AUDIO OUT jack J1408 through an r-f filter (part of the filter assembly) that prevents rf from radiating on the external leads of the r-f chassis.

4-31. UNIVERTER CHASSIS.

4-32. INTRODUCTION. During GS operation the output of the r-f chassis is connected to the univerter chassis (figure 4-2). The output frequency now required, 329.3 to 335.0 mc, is developed by mixing 129.3 to 135.0 mc from the r-f chassis with 200 mc from 200-mc oscillator V1510. The sum frequency at the output of univerter mixer V1511 is amplified by univerter amplifiers V1512 and V1513 and delivered to the GS OUTPUT jack. The overall gain of the univerter chassis is unity, so that the calibration of the MICROVOLTS control is true during GS operation. An avc (automatic volume control) circuit keeps the overall univerter gain constant over the complete range of the MICROVOLTS control. Plate voltage is applied to the univerter circuits when the NAV-GS switch is set to GS.



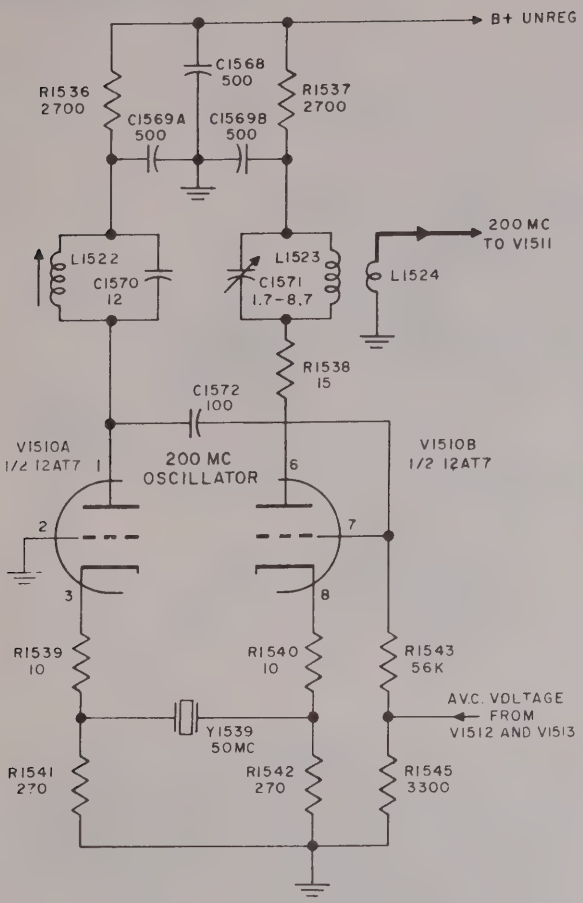


Figure 4-12. 200-Mc Oscillator V1510, Simplified Schematic

4-33. 200-MC OSCILLATOR V1510. (See figure 4-12.)

4-34. The 200-mc oscillator V1510 is a crystal-controlled, two-stage oscillator using both sections of a twin triode. The oscillator uses the fourth harmonic of crystal Y1539. Feedback to sustain oscillations is accomplished by connecting the plate V1510A to the grid of V1510B. V1510A acts as a grounded grid amplifier with the input signal fed to its cathode. The 200-mc oscillations appearing across L1523 are transformer coupled to L1524 in the cathode of univerter mixer V1511.

4-35. Plate voltage is applied to V1510A and B when the NAV-GS switch is set to GS. R-f filters in the plate circuits prevent rf from entering the B+ supply. Avc voltage from univerter amplifiers V1512 and V1513 is applied to the grid of V1512B, controlling the amplitude of oscillations for different settings of the MICROVOLTS control in order to keep the overall gain of the univerter chassis constant.

4-36. UNIVERTER MIXER V1511. (See figure 4-13.)

4-37. Univerter mixer V1511 receives the r-f outputs of the r-f chassis and 200-mc oscillator V1510 during GS operation. The output of the r-f chassis, 129.3 to 135.0 mc, is fed to the tuned grid circuit of V1511 and coupled through C1575 to the grid of V1511. The input is connected to a tap on L1524 to match the low output impedance of the r-f chassis. The output of 200-mc oscillator V1510 is transformer coupled to the cathode of V1511 by L1524. The sum frequency, 329.3 to 335.0 mc, is developed across L1526 and coupled to L1527 in the univerter amplifier V1512 grid circuit. The coupling circuit is overcoupled to have a broad response and pass all signals in the range 329.3 to 335.0 mc equally well.

4-38. UNIVERTER AMPLIFIERS V1512 AND V1513. (See figure 4-14.)

4-39. The 329.3 to 335.0-mc signal from V1511 is coupled through L1526 and L1527 to the grid of univerter amplifier V1512. The signal is amplified by V1512 and coupled through L1529 and L1530 to the grid of univerter amplifier V1513. The amplified signal appearing in the plate circuit of V1513 is coupled through L1531 and L1532 to GS OUTPUT jack J1501. The output is taken from a tap on L1532 in order to reduce the output impedance at the GS OUTPUT jack to approximately 53 ohms. (See paragraph 4-24.) The coupling circuits are overcoupled to have a broad response and pass all the required frequencies equally well.

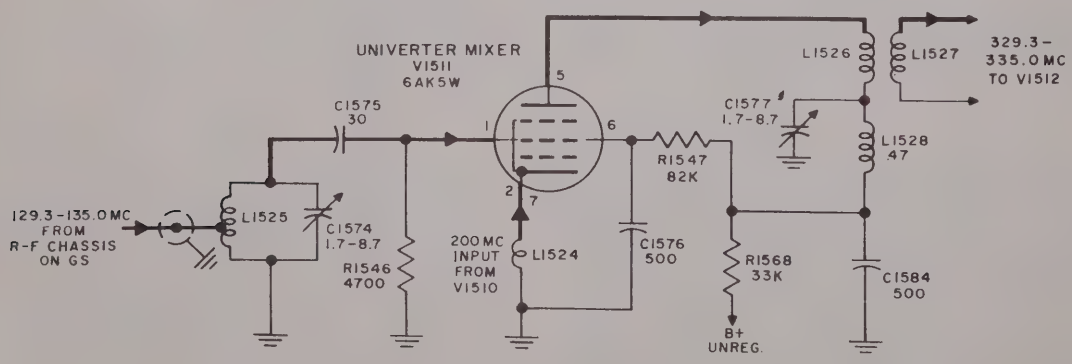


Figure 4-13. Univerter Mixer V1511, Simplified Schematic

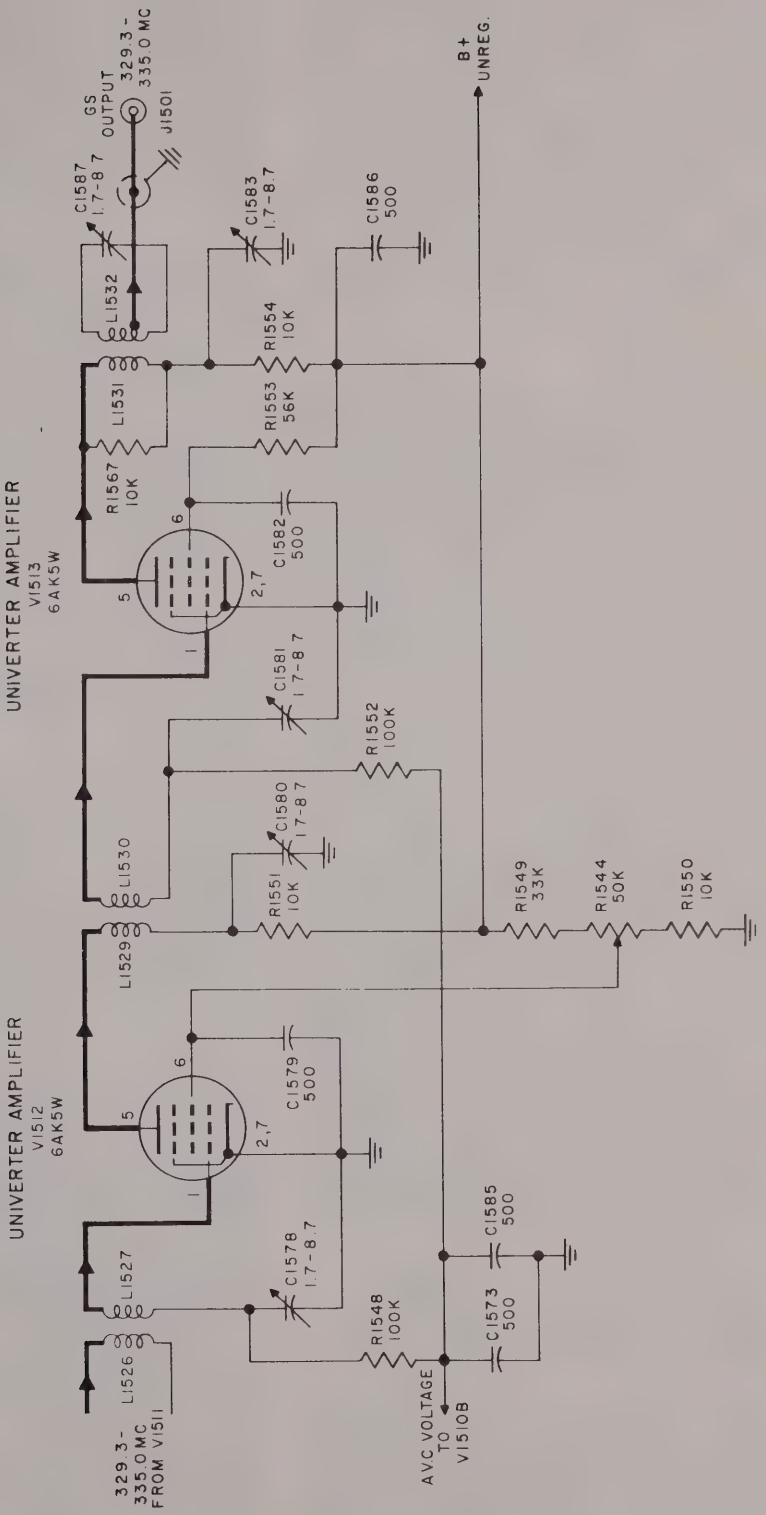


Figure 4-14. Univerter Amplifiers V1512 and V1513, Simplified Schematic

4-40. The r-f voltage developed across C1578 and C1581 in the grid circuits of V1512 and V1513 is used for automatic volume control in the univerter chassis. Avc capacitors C1573 and C1585 remove the r-f component of the signal and keep the overall gain of the univerter chassis constant for all settings of the MICROVOLTS control which varies the amplitude of r-f signal fed to the univerter during GS operation. The gain of the univerter chassis is also controlled by connecting the screen grid of V1512 to potentiometer R1544, part of a voltage divider across the B+ supply. R1544 allows the screen grid voltage to be varied between approximately 25 and 150 volts and is adjusted so that the overall gain of the univerter chassis is unity.

4-41. AUDIO CHASSIS.

4-42. INTRODUCTION. The audio chassis (figure 4-15) generates the various audio signals required for modulating the r-f carrier. The following audio signals are produced: 9960 cps frequency modulated at 30 cps, 1000 cps, 30 cps variable phase, 30 cps reversible phase, 90 cps and 150 cps. 9960 and 1000 cps oscillator V1406, an RC oscillator, produces 9960 cps or 1000 cps depending on the feedback network selected. The 9960 cps oscillator frequency is modulated at a 30 cps rate by frequency modulator V1407B during VOR, Φ LOC and 9960 FM operation. The oscillator output is also delivered to afc amplifier V1408A through cathode follower V1407A. Afc amplifier V1408A, in conjunction with discriminator V1409, stabilizes the oscillator frequency. During 1000$\sim$ operation the afc circuit is not used and the output of cathode follower V1407A is fed back through the 1000-cps feedback network to the oscillator. 30 cps is produced by a three stage RC oscillator V1401B, V1402A and B and amplified by 30 cps amplifier V1403. The amplified output is fed to a variable phase shifting network and cathode follower V1401A giving a 30 cps signal that can be shifted in phase in 45° steps. The output of V1403 is also fed to a reversible phase shifting network giving 30 cps with a reversible phase shift. Another portion of the V1403 output is fed to saturable reactor L1401 which distorts the signal. 90-cps filter Z1401 passes only the third harmonic and 150-cps filter Z1403 passes only the fifth harmonic of the distorted 30-cps signal. The 90 and 150-cps signals are fed to limiters V1405 and V1404 and then to the LOC-GS attenuator. The audio signals are all connected to AUDIO SELECTOR switch S1402 which selects the required audio signals and delivers them to a-f amplifier V1408B. The output of V1408B is fed to the r-f chassis.

4-43. 9960 AND 1000 CPS OSCILLATOR V1406, CATHODE FOLLOWER V1407A AND FREQUENCY MODULATOR V1407B. (See figure 4-16.)

4-44. Oscillator V1406 generates a 9960-cps signal frequency modulated at 30 cps during VOR, Φ LOC and 9960 FM operation. During 1000$\sim$ operation, V1406 generates a 1000 cps audio signal. A signal applied to the grid of V1406 will be amplified and will appear in the plate circuit 180° out of phase with the control grid signal. If the plate circuit signal is shifted another 180° and fed back to the grid circuit in phase with the original signal, oscillations will occur. In this oscillator, the signal from the plate of V1406 is coupled through C1426 to cathode follower V1407A. The cathode follower output in phase with its input, is fed through S1402D rear to the 9960-cps feedback network comprising C1427, R1465, C1425, R1458, C1423, R1456, R1457 and C1421 where the signal is shifted 180° at 9960 cps. The shifted signal is applied to the control grid of V1406 in phase with the original signal and oscillations occur at 9960 cps.

4-45. The first section of the 9960-cps feedback network is connected in parallel with the output impedance of frequency modulator V1407B. Any change in the output impedance of V1407B would cause the frequency of oscillation to change. A 30-cps signal from the 9960 FM DEV control is fed to the grid of V1407B. Therefore the output impedance of V1407B is varied at a 30 cps rate and hence the frequency of 9960 cps oscillation V1406 rises and falls at a 30 cps rate. Sufficient 30-cps signal is applied to V1407B to cause the oscillator frequency to change 480 cps on both sides of the 9960-cps center frequency. This represents a deviation ratio of 16 where deviation ratio = $\frac{\text{deviation from center frequency}}{\text{modulating frequency}} = \frac{480 \text{ cps}}{30 \text{ cps}} = 16$
The amount of 30-cps signal applied is controlled by 9960 FM DEV control R1421. The 9960-cps center frequency is stabilized by an afc circuit that controls the bias on V1407B which in turn changes the oscillator frequency whenever it drifts from the center frequency.

4-46. During 1000$\sim$ operation, AUDIO SELECTOR switch S1402D connects the 1000-cps feedback network to the grid circuit of V1406. The oscillator will now oscillate at a frequency of 1000 cps due to the new network, comprising C1418, R1453, C1419, R1454, R1455, C1420, R1456, R1457 and C1421, which will shift a 1000 cps signal 180°. 1000$\sim$ FREQ control R1455 changes the resistance of the feedback network and is used to adjust the oscillator frequency to 1000 cps. When operating on 1000 cps, frequency modulator V1407B and the afc circuit are not used.

4-47. During 1000$\sim$ operation, the output is taken from 1000$\sim$ LEVEL control R1464 in the cathode circuit of V1407A. The 1000-cps output is fed to AUDIO SELECTOR switch section S1402A. During VOR, Φ LOC and 9960 FM operation, the output is taken from 9960 FM LEVEL control R1467. The 9960 FM output is fed to AUDIO SELECTOR switch section S1402A. During GS operation one section of NAV-GS switch (figure 4-28) removes the B+ voltage from V1406 and V1407 thus disabling the circuit.

4-48. AFC AMPLIFIER V1408A AND DISCRIMINATOR V1409. (See figure 4-17.)

4-49. The 9960 FM output from cathode follower V1407A is also fed to the grid of afc amplifier V1408A. The signal is amplified and appears across the primary of discriminator transformer T1402. The secondary of T1402 is connected to discriminator V1409A and B. Capacitors C1437, C1436, C1433 and C1434

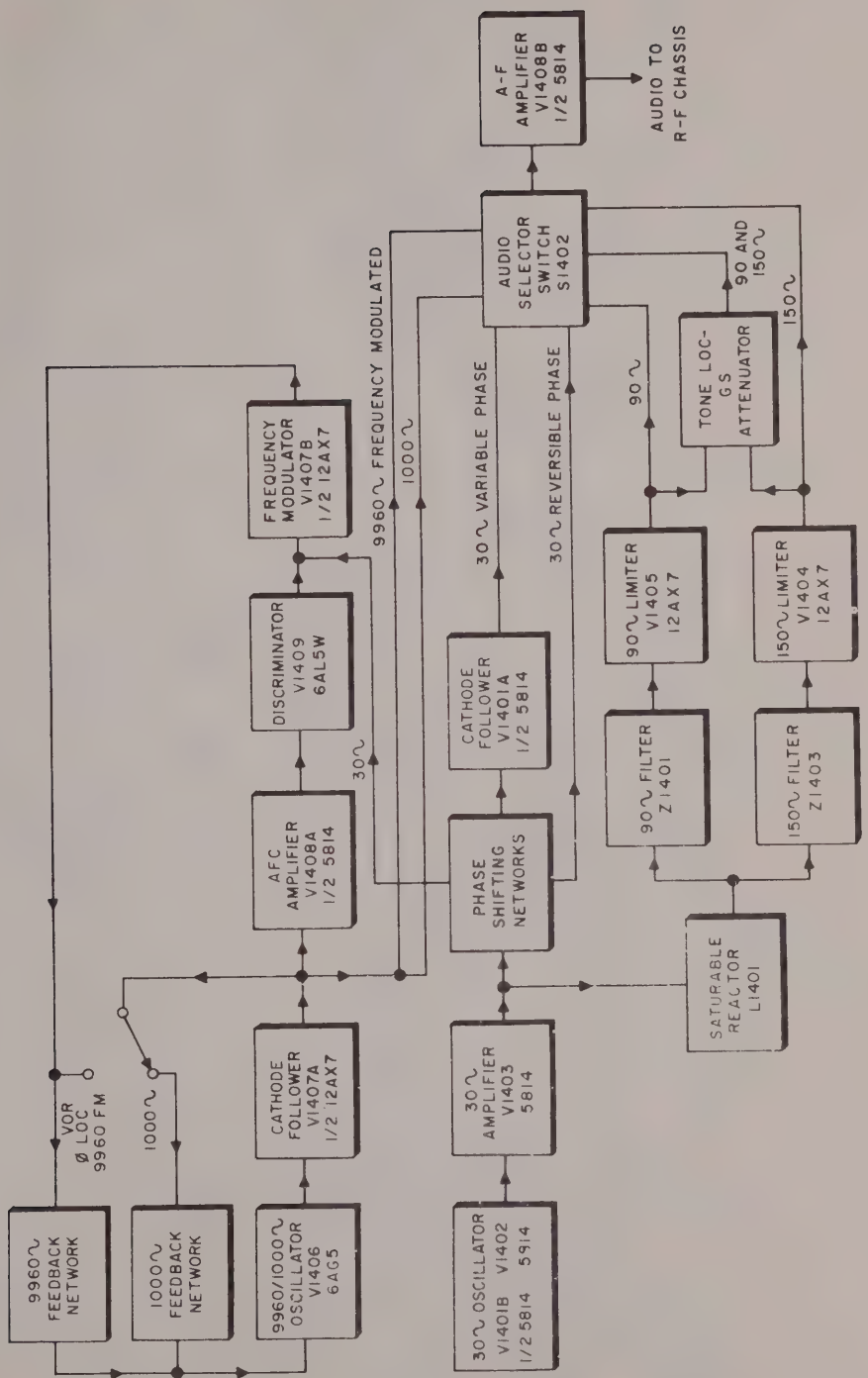


Figure 4-15. Signal Generator SG-13/ARN, Audio Chassis, Block Diagram

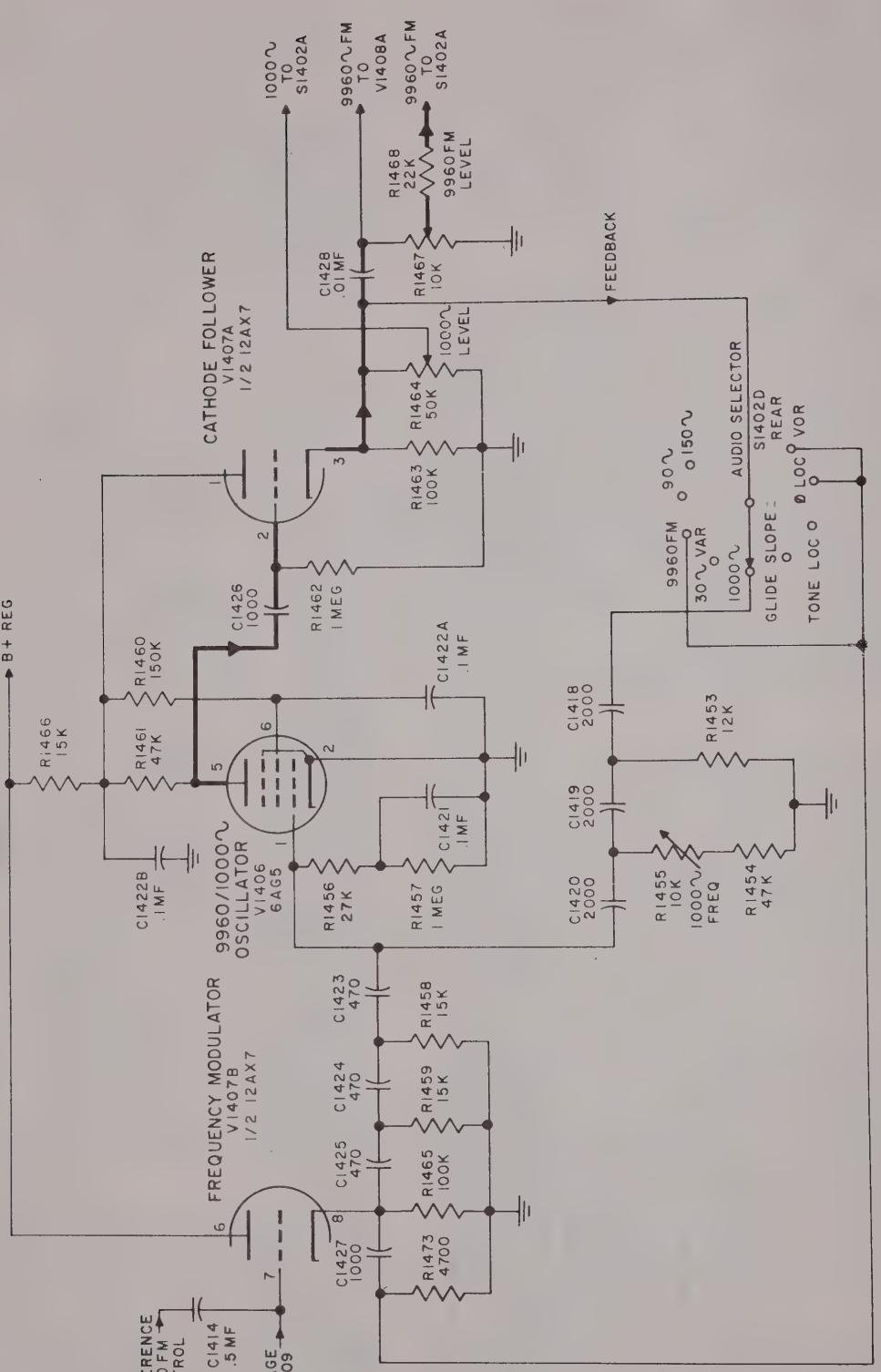


Figure 4-16. 9960 and 1000 CPS Oscillator V1406, Cathode Follower V1407A and Frequency Modulator V1407B, Simplified Schematic

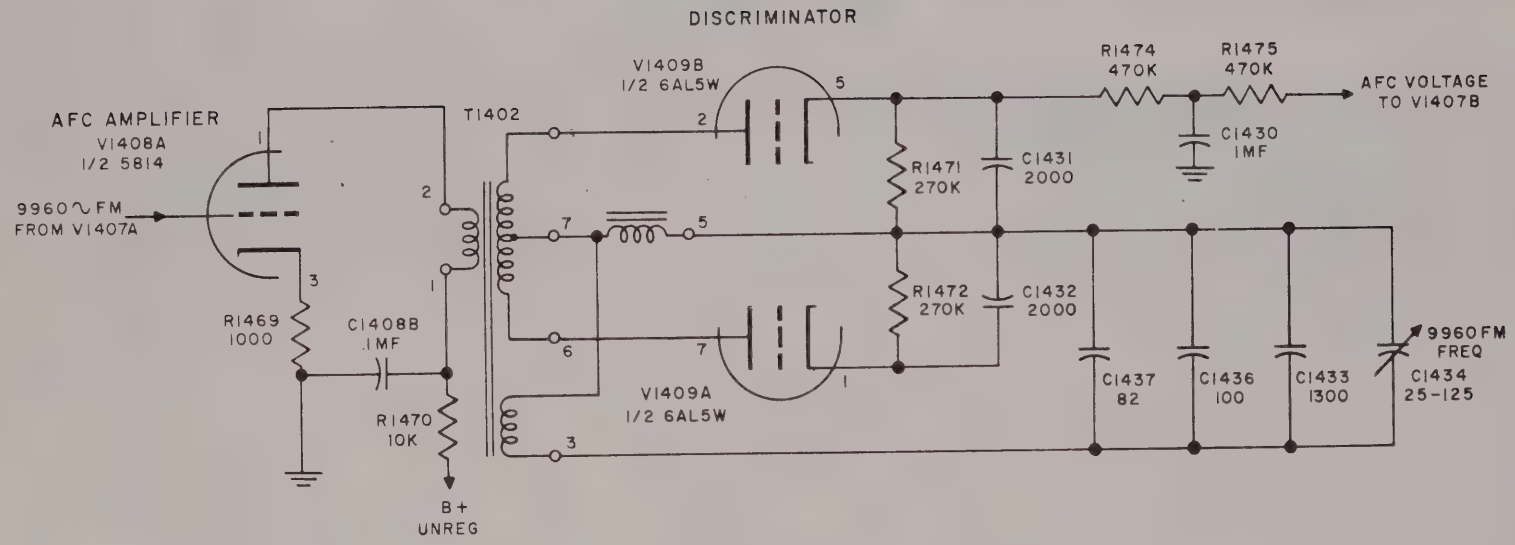


Figure 4-17. AFC Amplifier V1408A and Discriminator V1409, Simplified Schematic

tune the secondary to 9960 cps. 9960 FM FREQ control C1434 adjusts the center operating frequency of the discriminator which in turn controls the center frequency of V1406. When V1406 is operating with a center frequency of 9960 cps, the diodes V1409A and B conduct equally and equal but opposite voltages are developed across R1471 and R1472 giving no voltage in the output. When the V1406 frequency decreases, V1409B conducts more heavily than V1409A and a positive afc voltage appears in the output. This positive voltage is filtered by R1474, C1430 and R1475 to remove the 30-cps component and fed to the grid of frequency modulator V1407B (figure 4-16). A positive voltage on the grid of V1407B increases its cathode current or decreases the output impedance of V1407B. The decrease in output impedance will increase the frequency of V1406 so that it oscillates at 9960 cps.

4-50. When the V1406 frequency increases, V1409A conducts more heavily than V1409B and a negative afc voltage appears across R1471 and R1472. This negative voltage, fed to the grid of V1407B will decrease its cathode current or increase its output impedance. Therefore, the frequency of V1406 will decrease so that it oscillates at 9960 cps.

4-51. 30 CPS OSCILLATOR V1401B, V1402A AND B. (See figure 4-18.)

4-52. The 30 cps oscillator is an RC oscillator using three stages each having a gain of approximately two. Each stage is coupled to the next stage by a phase shifting network which will shift a 30-cps signal 60°. A signal at the grid of V1401B will appear at the plate of V1401B shifted 180°. This signal is coupled through a phase shifting network comprising C1402 and R1405 which shifts the signal another 60°. V1402A shifts the signal another 180° and C1403 and R1408 shift it another 60°. Therefore, the signal appearing at the grid of V1402B is shifted 480° from the signal on the grid of V1401B. V1402B shifts the signal 180° and C1401 and R1401 shift the signal 60°. This gives a total phase shift of 720° and the signal fed back to the grid of V1401B is in phase with the original signal and the circuit will oscillate at 30 cps.

4-53. Each of the three phase shifting networks has a temperature compensating network connected in series with it. The parallel combination of R1580 and R1581 is used to temperature compensate the C1401,

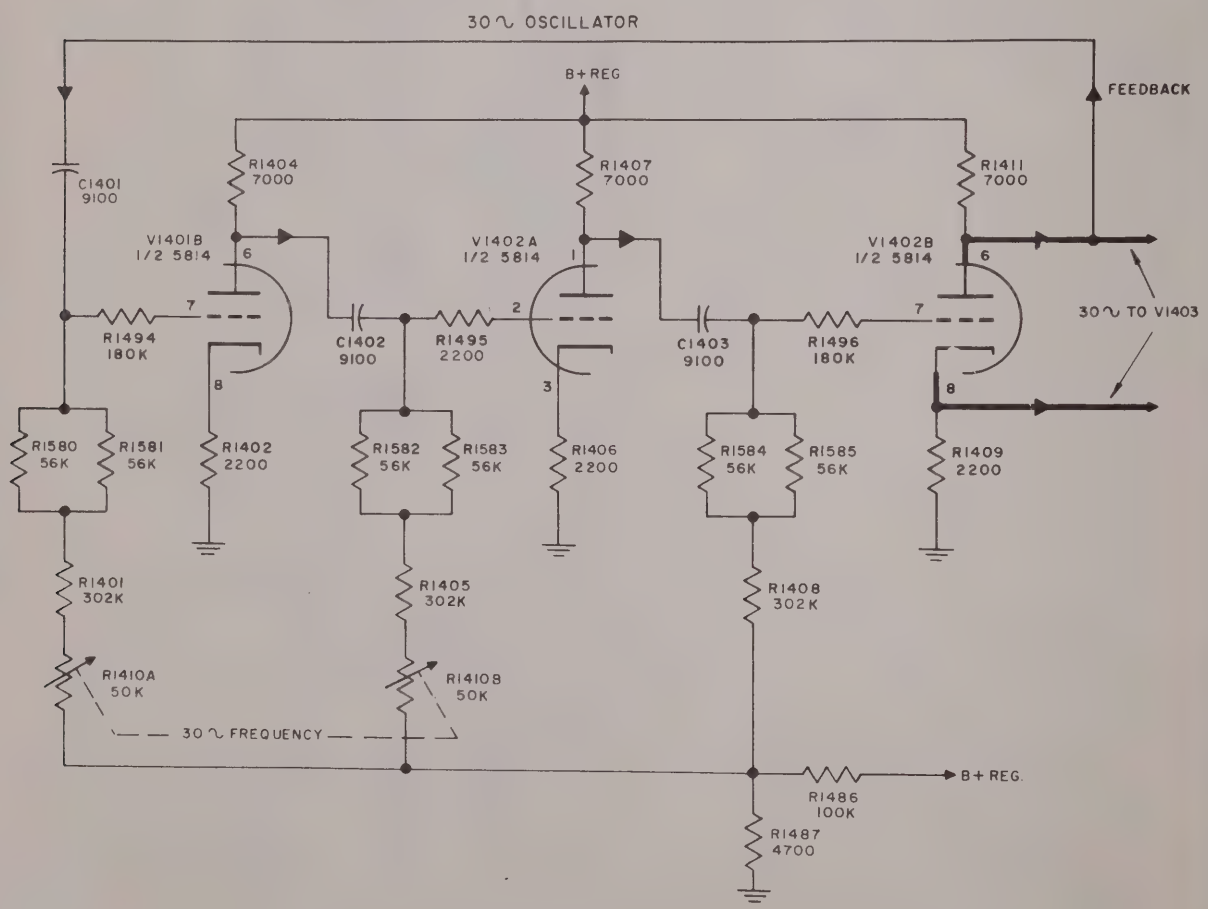


Figure 4-18. 30 CPS Oscillator V1401B, V1402A and B, Simplified Schematic

R1401 phase shifting network. R1582 and R1583 compensate C1402 and R1405. R1584 and R1585 compensate C1403 and R1408. Thermal resistors R1581, R1583 and R1585 have a negative temperature coefficient and R1580, R1582 and R1584 have a neglibibly low temperature coefficient. The combination of these two resistors has enough negative temperature coefficient to offset the inherent positive temperature coefficient of the phase shifting network. This balance prevents the oscillator frequency from varying appreciably with temperature change.

4-54. Dual potentiometer R1410A and B in series with the first two phase shifting networks allows approximately ±1 cps change in the oscillator frequency and is the 30∿ FREQUENCY adjustment. Fixed bias for the three stages is supplied from a voltage divider, comprising R1486 and R1487, across the regulated B+ supply. The 360-cps output is taken from the plate and cathode of V1402B giving two outputs each 180° out of phase for driving 30-cps amplifier V1403, a push-pull amplifier.

4-55. 30 CPS AMPLIFIER V1403. (See figure 4-19.)

4-56. The output of 30 cps oscillator V1402B is coupled through C1439 and C1438 and developed across voltage divider R1403 and R1415 in the V1403A grid circuit and voltage divider R1414 and R1413 in the V1403B grid circuit. The equal but out of phase signals are taken from the voltage dividers and fed to the grids of V1403A and B. The 30-cps signal in the output is developed across transformer T1401 and coupled through it to the variable and reversible phase shifting networks. The 30-cps output of V1403A is also fed to the 90 cps and 150 cps circuits V1405 and V1404.

4-57. VARIABLE PHASE SHIFTING NETWORK. (See figure 4-20.)

4-58. During VOR operation the 30-cps signal may be shifted in 45° steps with respect to the 30-cps reference signal of constant phase that frequency modulates the 9960 cps oscillator. The phase shifting network, comprising R1422, R1423, C1405 and C1406, is so proportioned that its resistance is equal to its capacitive reactance at 30 cps. VOR switch S1401A and B connects the resistors and capacitors of the phase shifting network in different arrangements across the secondary of T1401 (figure 4-21) to shift the phase as required. The output of the variable phase shifting network is fed to the grid of cathode follower V1401A. VOR TRACK potentiometer R1422 allows for a small variation in the network resistance for adjustment. Fixed bias for cathode follower V1401A is taken from voltage divider R1498 and R1497 across the regulated B+ supply.

4-59. Due to the various arrangements of the phase shifting network for different positions of the VOR switch, the signal at the grid of V1401A does not have the same amplitude on all positions of S1401. To keep the V1401A output constant, S1401C selects different points in the cathode circuit of V1401A in such a way as to make the 30 cps variable phase output signal constant for all VOR switch positions. VOR ZERO control in conjunction with C1415 allows for zeroing the circuit during calibration. The output is taken from 30∿ LEVEL control, which allows for amplitude adjustment of the signal, and fed through isolating resistor R1445 to AUDIO SELECTOR switch section S1402B.

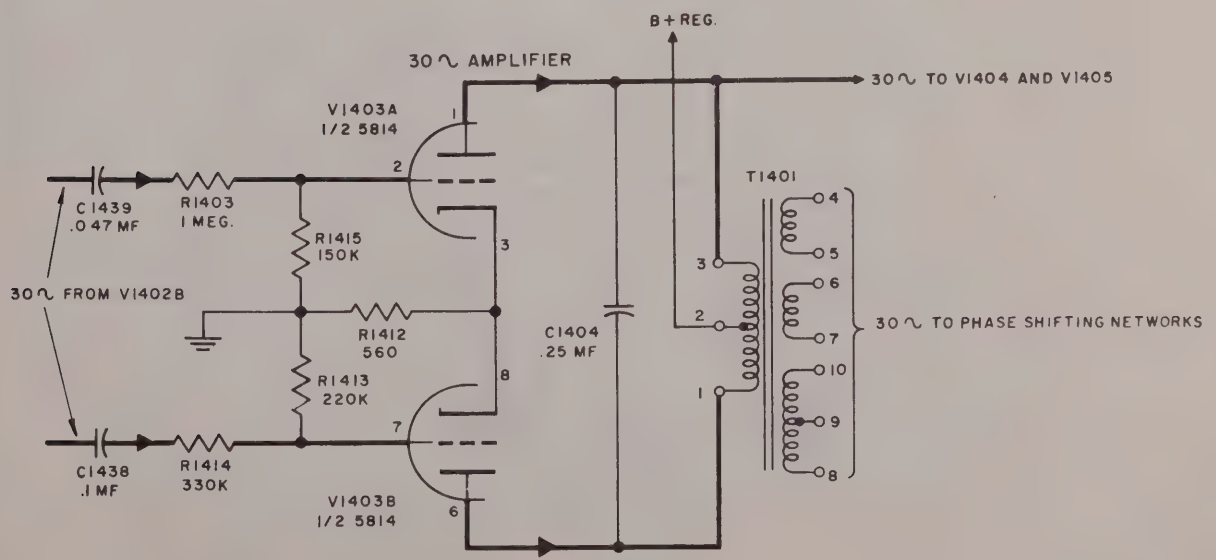


Figure 4-19. 30 CPS Amplifier V1403, Simplified Schematic

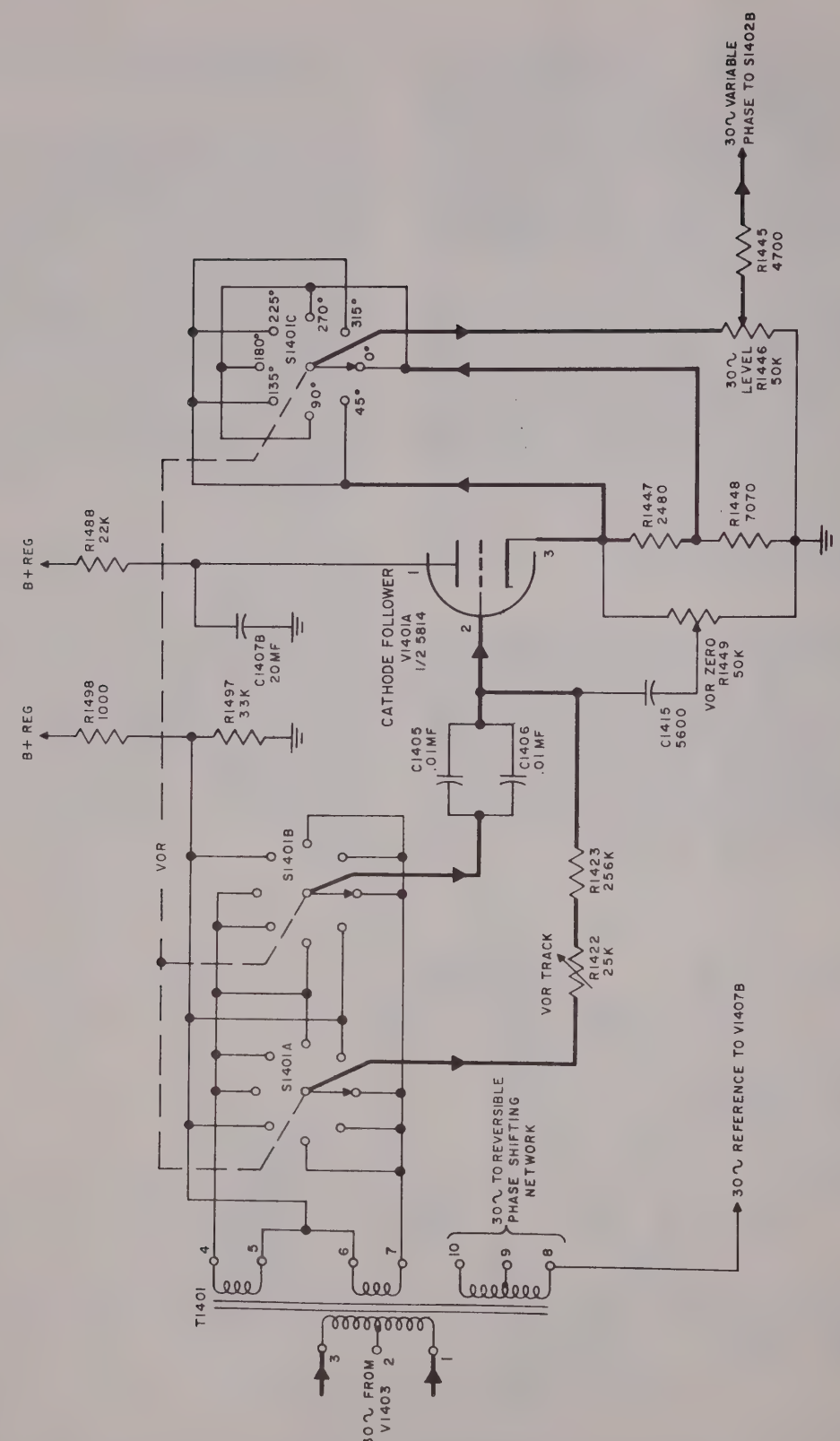
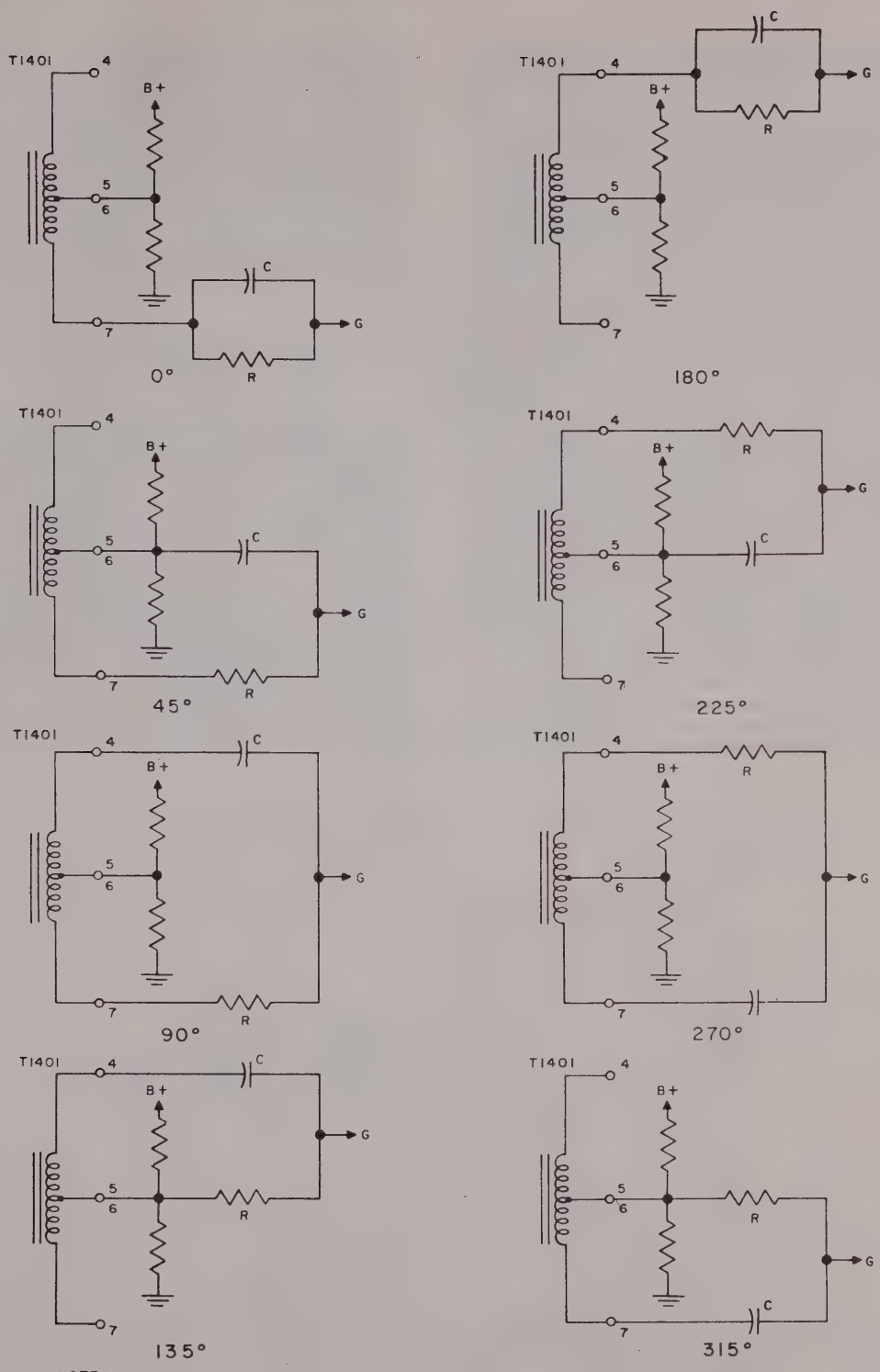


Figure 4-20. Variable Phase Shifting Network, Simplified Schematic



NOTE:
1. "C" REPRESENTS C1405 AND C1406 IN PARALLEL.
2. "R" REPRESENTS R1422 AND R1423 IN SERIES.
3. "G" CONNECTS TO GRID OF V1401A.

Figure 4-21. Variable Phase Shifting Network for Different Settings of VOR Switch

4-60. REVERSIBLE PHASE SHIFTING NETWORK. (See figure 4-22.)

4-61. During ϕ LOC operation the 30-cps signal may be in phase with the 30-cps reference signal that frequency modulates the 9960 cps oscillator or 180° out of phase with this reference signal. This is accomplished by using a center-tapped secondary of T1401 with the center tap grounded. Resistors R1416, R1417 and ϕ LOC CENTER control R1441 are connected across the secondary of T1401 forming a bridge circuit. The movable arm of R1441 is also grounded and the signal on one side of R1441 is 180° out of phase with the signal on the other side of ground. ϕ LOC LEVEL control R1485 in parallel with R1441 allows for setting the limit of the percentage of modulation as adjusted by LOC-GS control R1418B. LOC-GS control R1418B selects the phase and amplitude of the 30-cps signal during ϕ LOC operation. With LOC-GS control R1418B set to its midposition (middle of the white center segment on the front panel) there is no 30-cps output from this circuit. As the LOC-GS control is turned off center, a 30-cps signal in phase or 180° out of phase with the reference signal is fed through isolating resistor R1419 to AUDIO SELECTOR switch section S1402B. The phase of this signal depends on the direction of rotation of the LOC-GS control and its amplitude depends on how far off center the control is turned. With the LOC-GS control set to the top line of either the right or left segment, this signal should modulate the carrier 11.5 percent; on the bottom line the percentage modulation is 14 percent.

4-62. During VOR, ϕ LOC, 30∿ VAR ϕ and 9960 FM operation a 30-cps reference signal is taken from terminal 8 on T1401 for frequency modulating the 9960 cps oscillator. This reference signal may be shifted in phase one degree by changing the circuit constants with ±1 DEGREE switch S1405. This allows a one degree increment to be placed on any azimuth selected on the VOR switch. The reference signal appears across 9960 FM DEV control R1421 which controls the amount of frequency deviation of the 9960 cps oscillator. It is coupled through C1414 to frequency modulator V1407B.

4-63. 90 CPS AND 150 CPS CIRCUITS. (See figure 4-23.)

4-64. During TONE LOC, GLIDE SLOPE, 90∿ and 150∿ operation, 90 cps and/or 150 cps is used to modulate the r-f carrier instead of 9960 cps frequency modulated at 30 cps. A 30-cps signal of considerable amplitude is taken from 30 cps amplifier V1403 and is applied across saturable reactor L1401, a small audio reactor whose core is insufficiently large for the level involved and consequently saturates. This saturation causes the signal appearing across R1430 to be distorted and very rich in harmonics. Capacitor C1422C places the bottom of R1430 at a-f ground and acts as a d-c blocking capacitor for the plate voltage of V1403. AUDIO SELECTOR switch section S1402E disconnects the ground from the input circuit on VOR, ϕ LOC, 1000∿, 30∿ VAR ϕ and 9960 FM, thus disabling the circuit.

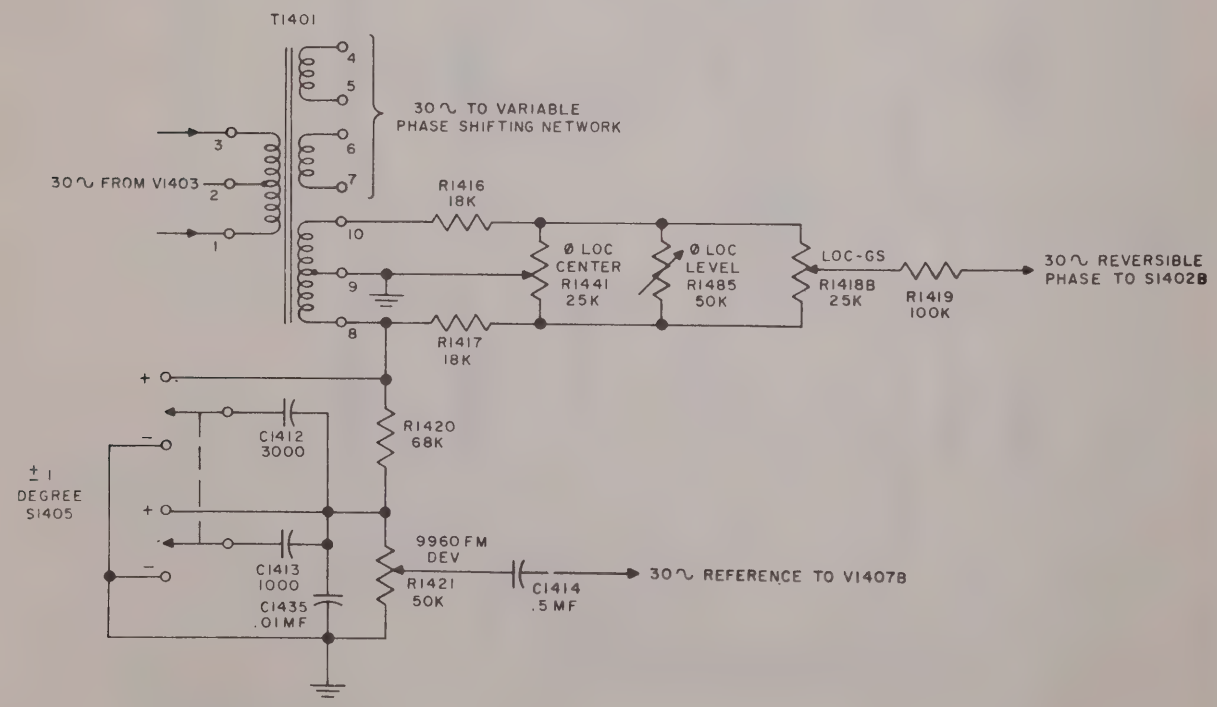


Figure 4-22. Reversible Phase Shifting Network, Simplified Schematic

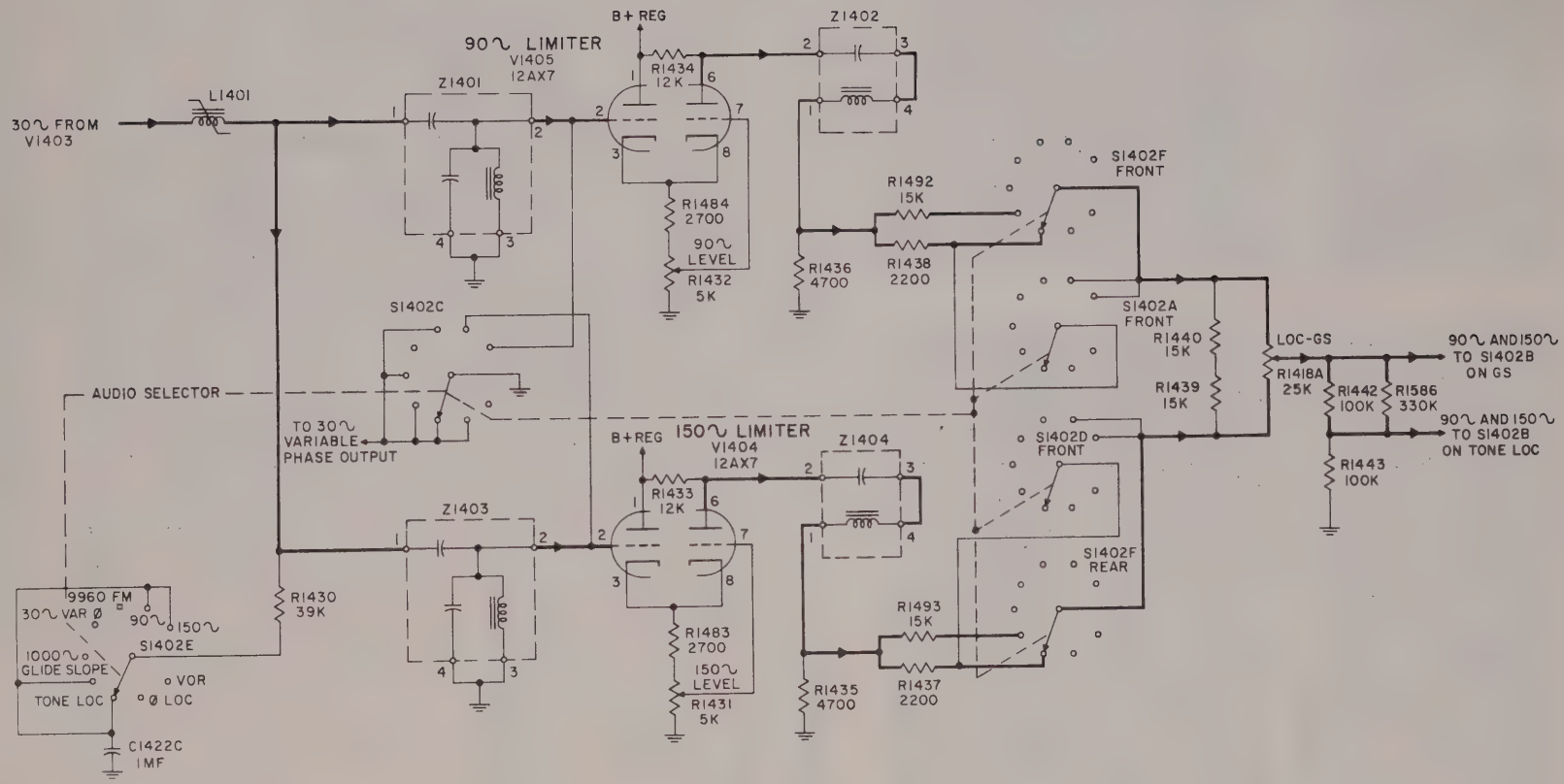


Figure 4-23. 90 CPS and 150 CPS Circuits, Simplified Schematic

4-65. The distorted signal is fed through Z1401 and Z1403, which pass only the third (90 cps) and fifth (150 cps) harmonics, respectively. The 90-cps signal is then fed to cathode-coupled limiter V1405 and the 150-cps signal is fed to cathode-coupled limiter V1404. AUDIO SELECTOR switch section S1402C disables the 30-cps variable phase signal on ϕ LOC, TONE LOC, GLIDE SLOPE, 1000∿ and 9960 FM by grounding the output of V1401A. On 90∿, S1402C grounds the grid of V1404 disabling the 150 cps circuit. On 150∿, S1402C grounds the 90 cps signal at the grid of V1405.

4-66. Limiters V1405 and V1404 keep the 90- and 150-cps signals at equal and constant amplitudes. 90∿ LEVEL control R1432 and 150∿ LEVEL control R1431 in the V1405 and V1404 cathode circuits control the output level of the limiters. Further filtering is provided by Z1402 and Z1404 and 90-cps and 150-cps signals of constant amplitude appear across R1436 and R1435, respectively.

4-67. For GLIDE SLOPE operation, the 90-cps and 150-cps signals are fed through dropping resistors R1492 and R1493 and AUDIO SELECTOR switch sections S1402F front and S1402F rear to LOC-GS attenuator R1418A. When the LOC-GS is set to its midposition (middle of the white center segment on the front panel), equal amounts of 90-cps and 150-cps signal are fed to AUDIO SELECTOR switch section S1402B and each signal will modulate the r-f carrier 40 percent. When the LOC-GS control is set to the top line on the left segment, the 90-cps level will fall as the 150-cps level rises until the 150-cps signal is 3.0 db higher than the 90-cps signal. If the LOC-GS control is set to the bottom line on the left segment there is a 3.75 db difference between signals. When the LOC-GS is set to the right segment, the signals are reversed and the 90-cps level becomes greater than the 150-cps level.

4-68. For TONE LOC operation, the 90-cps and 150-cps are fed through dropping resistors R1438 and R1437 and AUDIO SELECTOR switch sections S1402F front and S1402F rear to LOC-GS attenuator R1418A. The 90-cps and 150-cps levels at its midposition are still equal, but when the control is set to the top line of the right or left segment there is a 6.0 db difference in signal levels. At the bottom line of either segment the level difference is now 7.5 db. Since only 20% modulation is required for each tone for an on-course signal in TONE LOC, the output of the attenuator is reduced by voltage divider R1442, R1586 and R1443. On 90∿ and 150∿ AUDIO SELECTOR switch sections S1402A front and S1402D front are used and the output is also taken from the voltage divider.

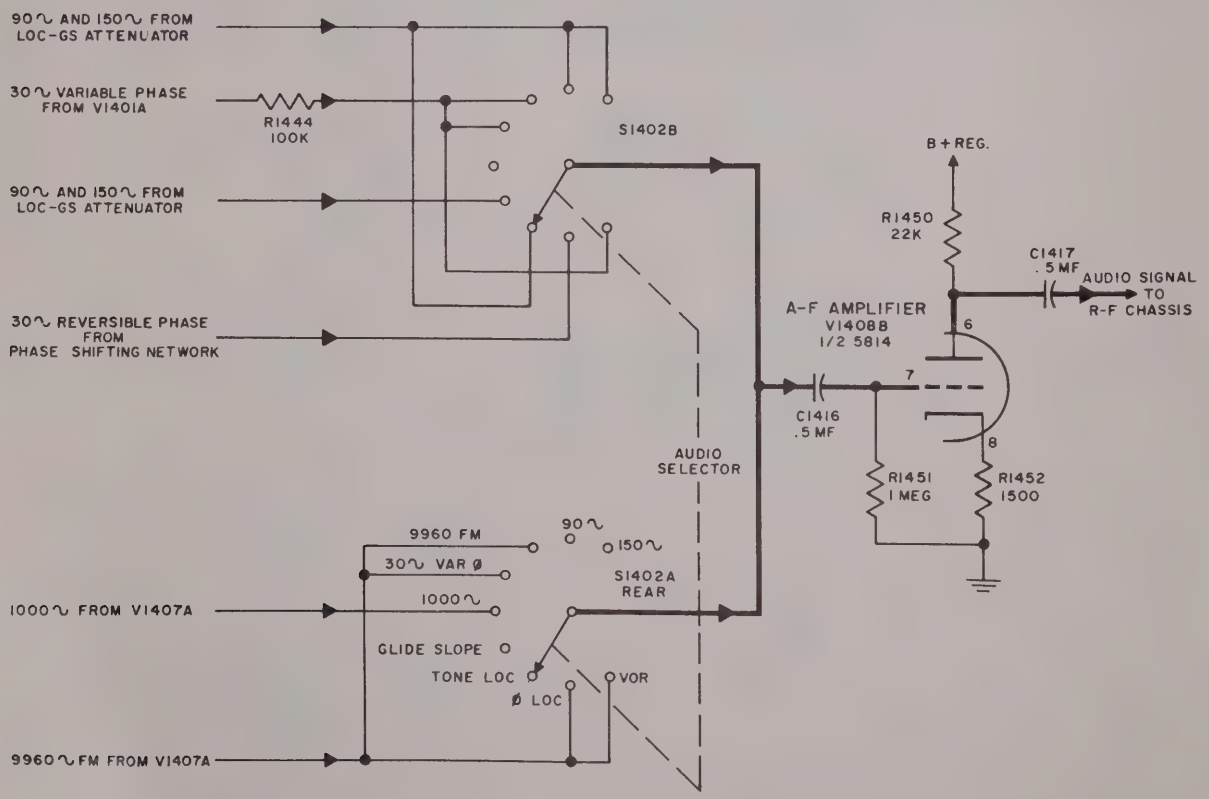


Figure 4-24. Audio Output Circuit, Simplified Schematic

4-69. AUDIO OUTPUT CIRCUIT. (See figure 4-24.)

4-70. The audio output circuit consists of AUDIO SELECTOR switch sections S1402B and S1402A and a-f amplifier V1408B. All the audio signals produced by the audio chassis are fed to these two switch sections and are mixed, amplified by V1408B, an amplifier common to all audio signals, and fed to the r-f chassis. The audio signals are selected as follows:

a. VOR. 9960 cps frequency modulated at 30 cps from V1407A is fed to S1402A rear and 30 cps variable phase from V1401A is coupled through R1444 to S1402B. Switch section S1402E (figure 4-22) disables the 90 cps and 150 cps circuit.

b. ϕ LOC. 9960 cps frequency modulated at 30 cps from V1407A is fed to S1402A rear and 30 cps reversible phase from its phase shifting network is fed to S1402B. Switch section S1402C (figure 4-23) grounds the 30 cps variable phase signal and S1402E disables the 90 cps and 150 cps circuit.

c. TONE LOC. 90 cps and 150 cps from the LOC-GS attenuator are fed to S1402B. Switch section S1402C again grounds the 30 cps variable phase signal and section S1402D (figure 4-16) disables the 9960 cps oscillator.

d. GLIDE SLOPE. Same as in TONE LOC except signal amplitude is greater.

e. 1000$\sim$. 1000 cps from V1407A is fed to S1402A rear. Switch section S1402C again grounds the 30 cps variable phase signal and S1402E disables the 90 cps and 150 cps circuit.

f. 30$\sim$ VAR ϕ. 30 cps variable phase from V1401A is coupled through R1444 to S1402B. Switch section S1402D disables the 9960 cps oscillator and S1402E disables the 90 cps and 150 cps circuit.

g. 9960 FM. 9960 cps frequency modulated at 30 cps from V1407A is fed to S1402A rear. Switch section S1402C grounds the 30 cps variable phase signal. R1444 prevents the 9960 cps signal from being grounded at the same time. Switch section S1402E disables the 90 cps and 150 cps circuit.

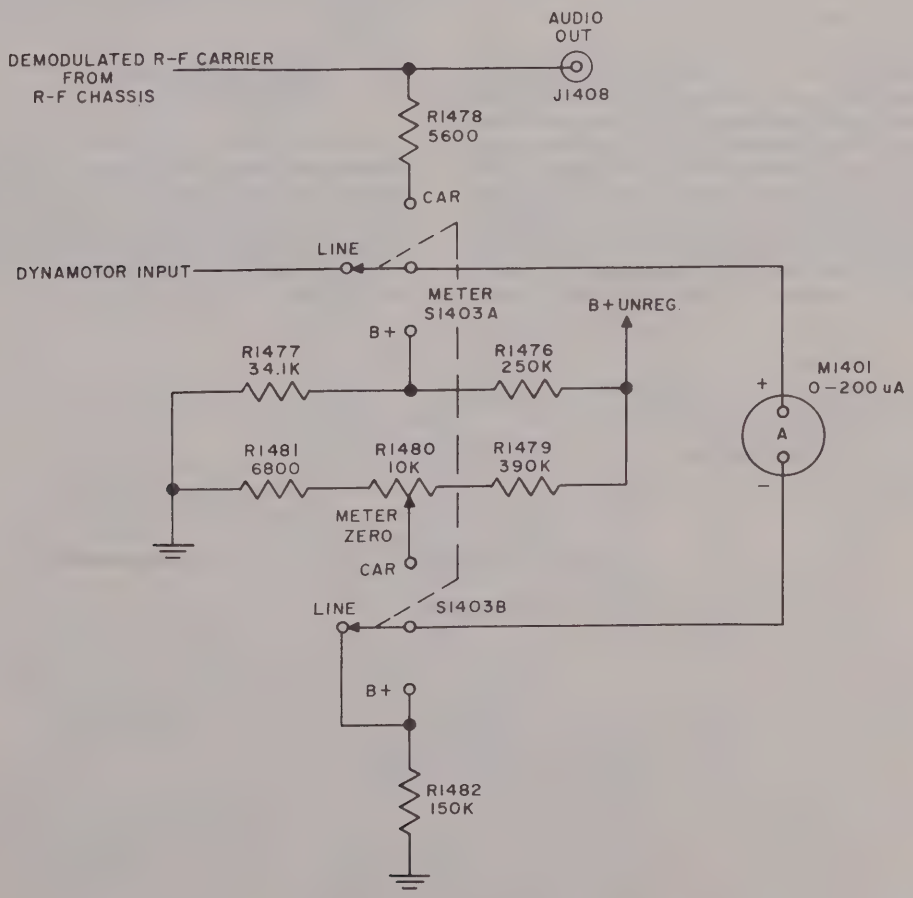


Figure 4-25. Meter Circuit, Simplified Schematic

h. 90∿. 90 cps from the LOC-GS attenuator is fed to S1402B and all other audio circuits are disabled.

i. 150∿. 150 cps from LOC-GS attenuator is fed to S1402B and all other audio circuits are disabled.

4-71. METER CIRCUIT.
(See figure 4-25.)

4-72. Meter M1401 is provided on the front panel for measuring the unregulated B+ voltage, the adjusted line voltage (dynamotor input) and the carrier level. The meter has a 0 to 200 microampere movement and with METER switch S1403 in the LINE and B+ positions it is converted to a 0 to 30 volt d-c voltmeter by adding multiplier resistor R1482 in series with it. With S1403 in the B+ position, voltage divider R1476 and R1477 provides a 10 to 1 reduction in the unregulated B+ voltage so that it can be measured by the 0 to 30 volt voltmeter. In the CAR position, the meter is connected to the demodulated output of the r-f chassis and to METER ZERO control R1480 which is used to zero the meter when no r-f signal is applied to demodulator V1509 in the r-f chassis. AUDIO OUT jack J1408 provides a convenient test point for checking the audio signals.

4-73. POWER SUPPLY.

4-74. INTRODUCTION. The power supply (figure 4-26) receives the input voltage, 21 to 29 volts dc, from the power source and supplies 21 volts dc for the signal generator tube filaments and +230 volts unregulated and +150 volts regulated for B+ voltages. 21 to 29 volts dc from the power source is fed through the line voltage control which allows setting the input voltage to 21 volts. The 21-volt output is fed to dynamotor D1401 and supplies filament power to the audio, univerter and r-f chassis. The dynamotor output feeds the power supplies which use the +230-volt unregulated output and three +150-volt regulated outputs from voltage regulator V1410, V1411 and V1412. These B+ voltages are used throughout the signal generator.

4-75. POWER INPUT AND DYNAMOTOR CIRCUIT.
(See figure 4-27.)

4-76. Power Cord CX-1095/U connects 21 to 29 volts dc to the input receptacle J1402. Fuses F1401 and F1402 protect both input lines. The input power is fed to SET LINE TO 21V control S1404 whose contacts connect 0.2-ohm resistors in series with the input line as required to reduce the input voltage to 21 volts. When turned fully counterclockwise to OFF, S1404 disconnects all power from the signal generator. The output of the line voltage control is fed to pilot lamp I1401 for power-on indication, to the signal generator filament circuits, to the meter circuit for measurement, and through input filter C1407 and L1402 to dynamotor D1401. The dynamotor is a d-c motor operating on 21 volts with a common rotor that generates 260 volts. Capacitors C1411 and C1410 across the dynamotor brushes reduce arcing at the commutators. The 260-volt dynamotor output is filtered by L1403 and C1408A and fed to the power supplies.

4-77. POWER SUPPLIES.
(See figure 4-28.)

4-78. The 260-volt dynamotor output is coupled through RC filter R1428 and C1407C which drops the voltage to 230 volts for use by V1408A and the r-f chassis as B+ voltage. 230 volts is also fed through NAV-GS switch S1406 to the univerter chassis. When in NAV operation, the univerter chassis is not required and S1406 disconnects its B+ supply. The

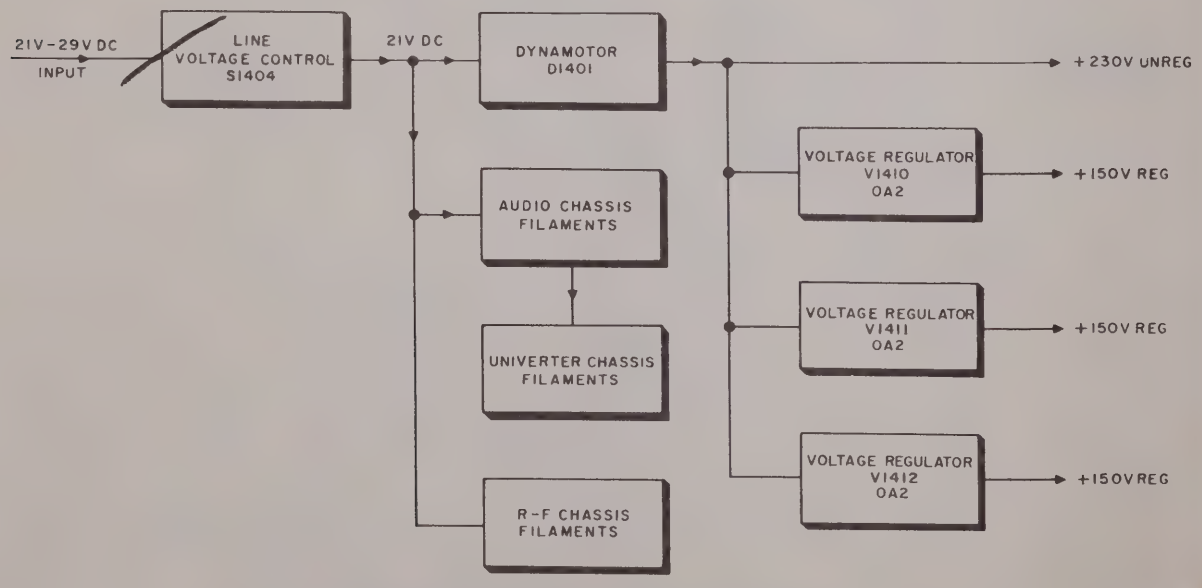


Figure 4-26. Power Supply, Block Diagram

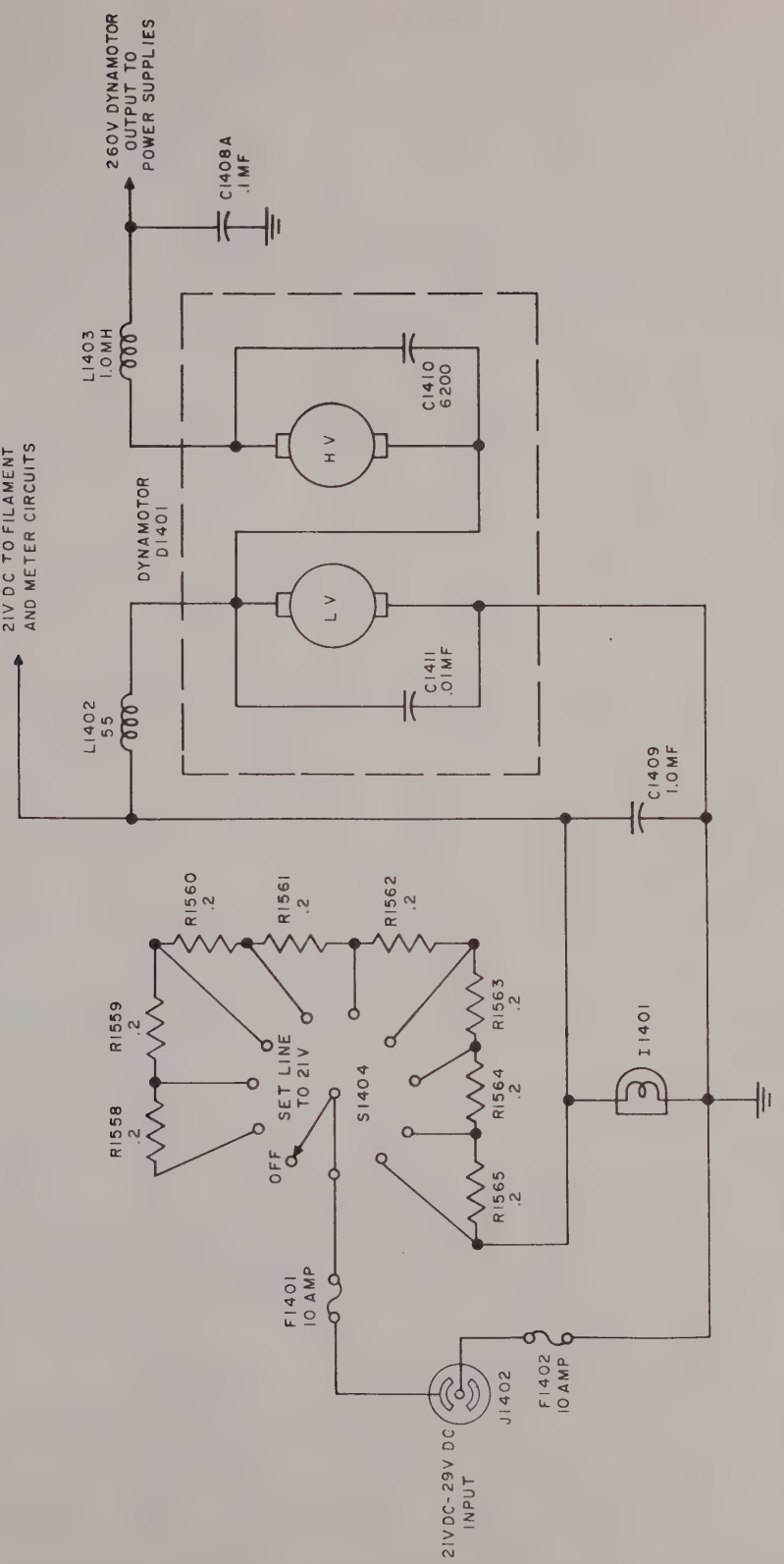


Figure 4-27. Power Input and Dynamotor Circuit, Simplified Schematic

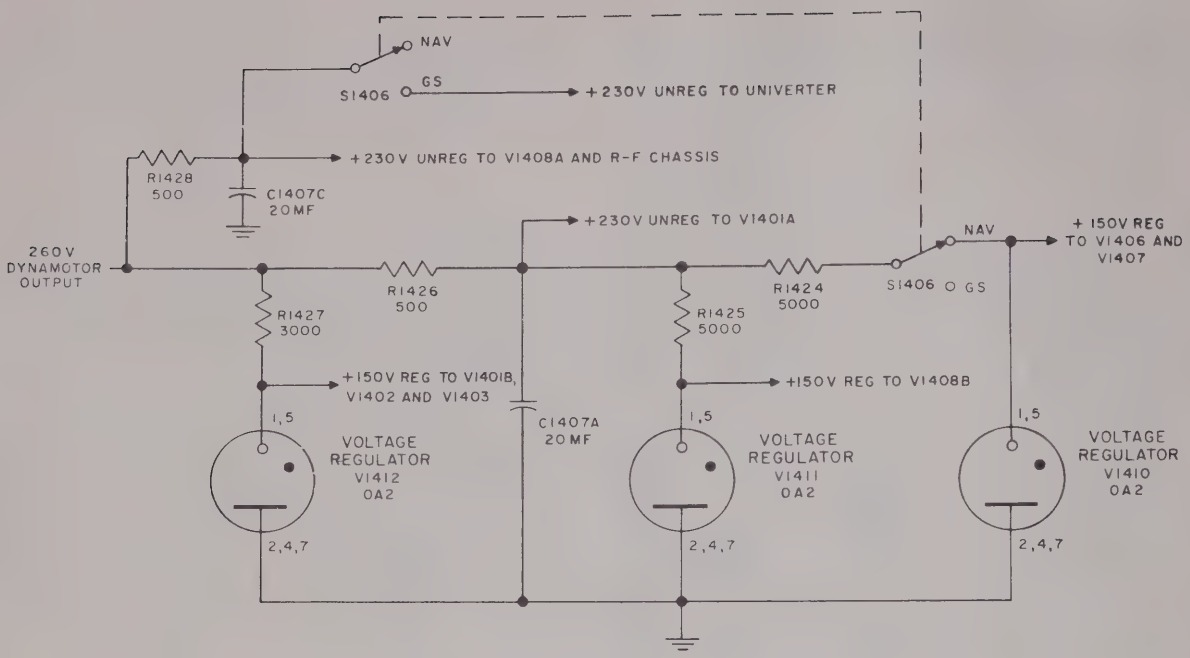


Figure 4-28. Power Supplies, Simplified Schematic

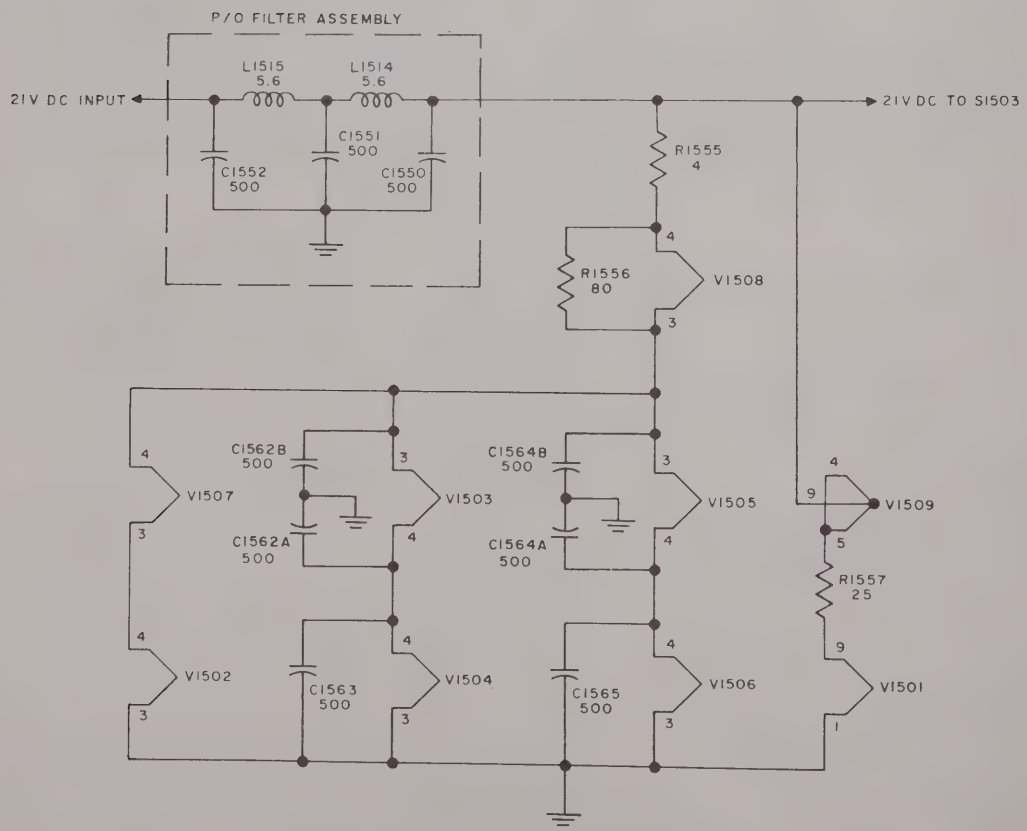


Figure 4-29. R-f Chassis Filament Circuit, Simplified Schematic

dynamotor output is also fed through RC filter R1426 and C1407A and the 230-volt output is used by V1401A as B+ voltage. Voltage regulator V1412, in series with dropping resistor R1427 across the dynamotor output, produces a regulated +150 volts for use as B+ voltage by V1401B, V1402 and V1403. Voltage regulator V1411 and R1425 across the 230-volt line, produce a regulated +150 volts for use as B+ voltage by V1408B. Voltage regulator V1410 and R1424 across 230 volts, produce a regulated +150 volts for use as B+ voltage by V1406 and V1407. A section of NAV-GS switch disconnects V1410 during GS operation, removing B+ voltage from V1406 and V1407 and disabling the 9960 cps oscillator circuit. The three separate regulated voltages are used in the audio chassis to keep the audio levels constant and to prevent B+ interaction.

4-79. FILAMENT CIRCUITS.
(See figures 4-29 and 4-30.)

4-80. The 21-volt output of the line voltage control is used to energize all the signal generator filaments. Voltage dropping resistors and various series-parallel combinations of filaments are used to supply the required voltage to individual tube filaments. The r-f and univerter chassis use r-f filters that prevent rf from entering the filament circuits.

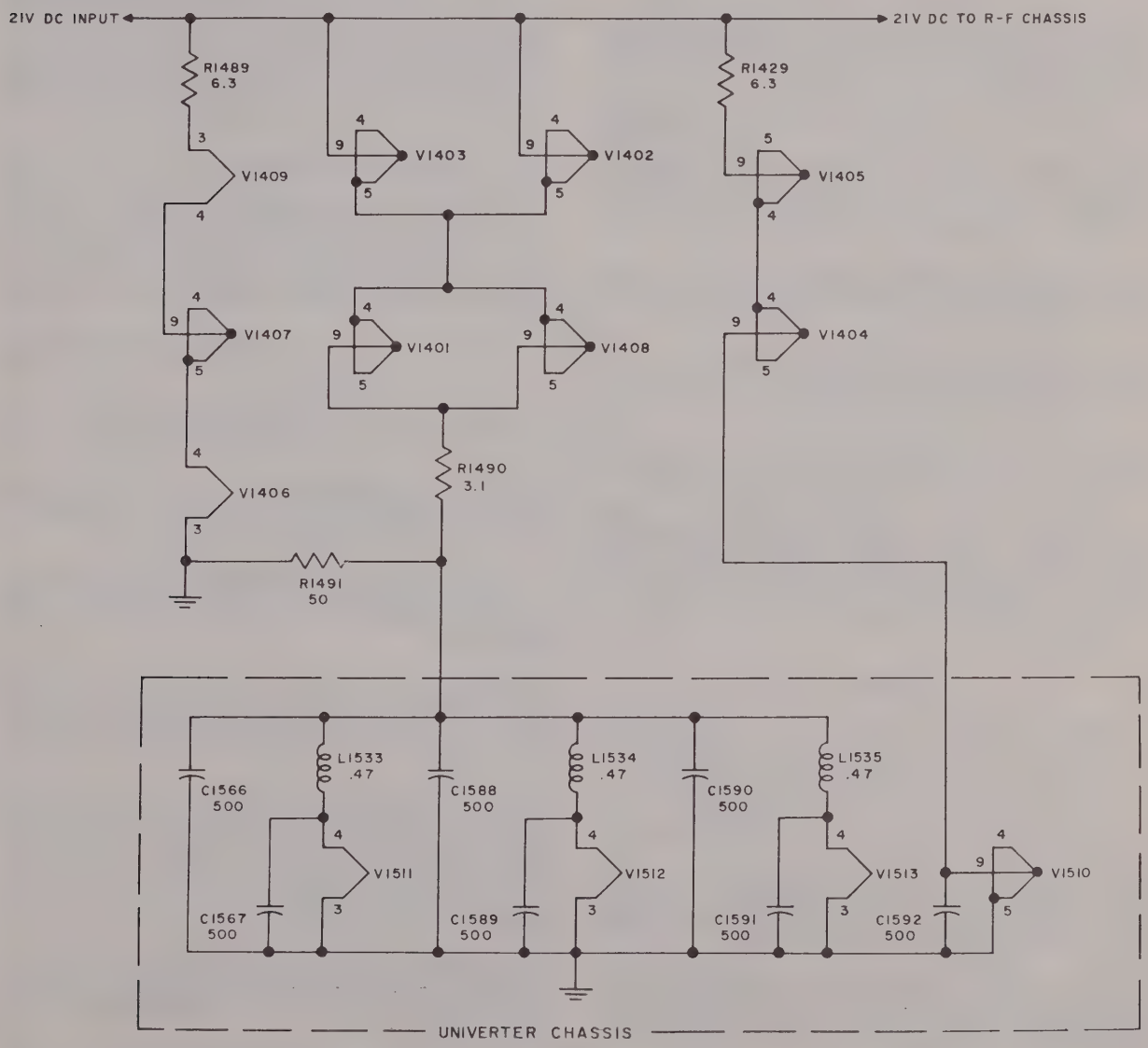


Figure 4-30. Audio and Univerter Chassis Filament Circuit, Simplified Schematic

SECTION V

OPERATIONAL AND ORGANIZATIONAL MAINTENANCE

5-1. MINIMUM PERFORMANCE STANDARDS.

5-2. INTRODUCTION. The following paragraphs list the minimum standards of performance for Signal Generator SG-13/ARN. When making these tests, if it is found that the result is below the minimum performance standards, check all logical causes of trouble (paragraph 5-10) before undertaking realignment of the circuit. See Section VI, paragraph 6-37.

5-3. OVERALL OPERATIONAL CHECK: Make the following checks to determine the operability of the signal generator.

a. Turn SET LINE TO 21V control to OFF position.

b. Connect either Power Cable Assembly CX-1095/U or CX-1506/U to the 21V DC-29V DC connector on the signal generator and connect the other end of the cable to a 21 to 29-volt power source.

c. Set METER switch to LINE position and adjust SET LINE TO 21V control for a meter reading of 21 ±0.5 volts.

d. Allow 3 minutes warm-up and set METER switch to B+ position. Note the voltage reading on the meter. It should be approximately 230 volts.

e. Set METER switch to CAR position and CARRIER SET control fully counterclockwise past the click.

f. Check the meter for a zero reading. If the meter does not give a zero reading, adjust METER ZERO control. The METER ZERO control is located behind the small louvered access cover on the right side of the signal generator front panel.

NOTE

This adjustment is not critical. The meter may be off zero by several divisions with only a small error in r-f attenuator calibration.

g. Set MICROVOLTS control to its maximum (200K).

h. Set METER switch to CAR position and set the meter to the red line with CARRIER SET control at each MEGACYCLES control position of its outer knob 1-mc steps from 135.5 down to 108.5 mc.

i. Set the outer knob of MEGACYCLES control to 108 mc and red line the meter with CARRIER SET control at each tenth megacycle step of the inner knob of MEGACYCLES control.

j. If the meter cannot be set to the red line, faulty operation of the r-f chassis is indicated. Refer to Section VI, paragraph 6-5 for isolation of trouble and corrective procedure.

k. Connect a cathode ray oscilloscope to test point ⏢, AUDIO OUT connector J1408, behind the louvered access cover on the right side of the signal generator front panel.

l. Set AUDIO SELECTOR switch to each of its nine positions and check waveforms obtained as described in Section VI, paragraph 6-13. Excessive distortion may be an indication of a defective tube or component in the audio chassis. Noise or ripple on the waveforms is often an indication of defective dynamotor operation. See Section VI, paragraph 6-16.

5-4. VOR ACCURACY CHECK.

a. Connect the signal generator through a 6-db, 53-ohm attenuator pad UG-528/U to an AN/ARN-14 navigation receiver equipped with omni bearing selector (OBS) and Course Indicator ID-249A/ARN. See A of figure 5-1 for connections and omit the microammeter.

b. Set the frequency of the signal generator and receiver to 114.9 mc and set NAV-GS switch to NAV.

c. Turn on the signal generator and adjust SET LINE TO 21V control for 21 ±0.5 volts on the meter.

d. Allow the signal generator to warm up for at least 15 minutes and set METER ZERO and adjust CARRIER SET for a red line indication on the meter.

e. Set AUDIO SELECTOR to VOR, VOR switch to 0°, and MICROVOLTS dial to 1000. Check 30∿ FREQUENCY adjustment as given in Section VI, paragraph 6-44.

f. Adjust SET control on Course Indicator ID-249A/ARN until the crosspointer is centered with SET control at approximately 0° with TO-FROM indicator reading TO.

g. Disconnect the signal generator and substitute Modulator MD-83A/ARN modulating Signal Generator SG-1/ARN with a standard VOR signal. See B of figure 5-1 for connections and omit the microammeter. Do not change the setting of SET control on Course Indicator ID-249A/ARN.

h. Set the SG-1/ARN output level for 500 microvolts and vary the MD-83A/ARN VOR dial setting until the crosspointer is again centered with TO-FROM indicator reading TO.

i. Note the MD-83A/ARN VOR dial reading and subtract the SG-13/ARN VOR switch setting (in this case, 0°) to obtain the VOR error.

j. Repeat steps a through i for each setting of the SG-13/ARN VOR switch. VOR error should not exceed ±0.75° at any setting of the VOR switch.

5-5. TONE LOCALIZER CENTERING ACCURACY CHECK.

a. Connect Signal Generator SG-1/ARN modulated with Modulator MD-83A/ARN to an AN/ARN-14 receiver equipped with Course Indicator ID-249A/ARN. Use a 6-db, 53-ohm attenuator pad at the receiver input and connect Weston Model 901 microammeter in parallel with the NAV crosspointer coil in ID-249A/ARN. See B of figure 5-1 for connections.

b. Set the frequencies of the receiver and signal generator to 110.1 mc and adjust the SG-1/ARN output level for 500 microvolts.

c. Modulate the SG-1/ARN with a zero db tone localizer signal and adjust the receiver for zero crosspointer current. Refer to receiver handbook for location of this adjustment.

d. Substitute Signal Generator SG-13/ARN set to 110.1 mc for the MD-83A/ARN and SG-1/ARN combination. See A of figure 5-1 for connections.

e. Allow the SG-13/ARN to warm up for at least 15 minutes and red line the meter.

f. Set AUDIO SELECTOR to TONE LOC, MICROVOLTS dial to 1000, and LOC-GS control to the center of the white segment (on course). The crosspointer current as read on the Model 901 microammeter should be 0 ±8 microamperes.

5-6. TONE LOCALIZER 6-DB ACCURACY CHECK.

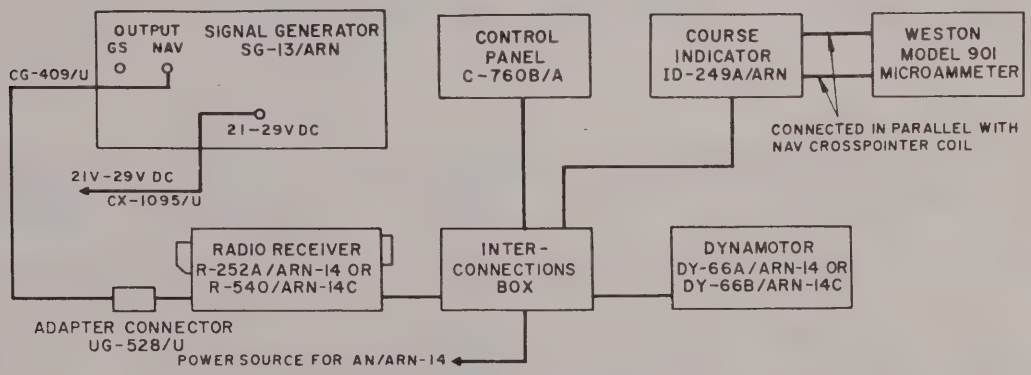
a. Perform steps a and b of paragraph 5-5.

b. Modulate the SG-1/ARN with a 4-db left tone localizer signal and adjust the receiver for 90 microamperes crosspointer current.

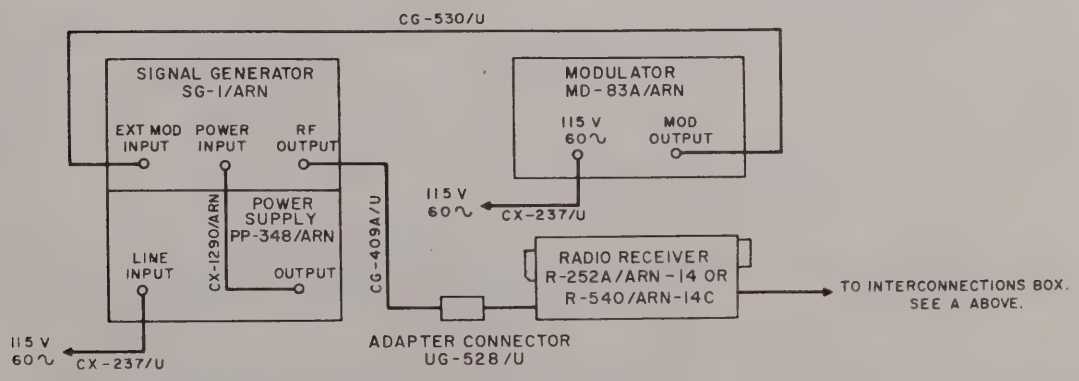
c. Perform steps d and e of paragraph 5-5.

d. Set AUDIO SELECTOR to TONE LOC, MICROVOLTS dial to 1000, and LOC-GS control to the top line of the left segment (6-db left tone localizer signal) The crosspointer current should be 135 ±15 microamperes.

e. Repeat steps a through d above for a 6-db right tone localizer signal.



A.



B.

Figure 5-1. Test Setup, VOR Accuracy Check

5-7. GLIDE SLOPE CENTERING ACCURACY CHECK.

a. Connect Signal Generator SG-2/GRM-4 through a 6-db, 53-ohm attenuator to an AN/ARN-18 glide slope receiver equipped with Course Indicator ID-249A/ARN. See B of figure 5-2 for connections.

b. Set the frequencies of the signal generator and receiver to 332.0 mc and adjust the SG-2/GRM-4 output level for 500 microvolts.

c. Modulate the SG-2/GRM-4 with a zero db glide slope signal and adjust the receiver for zero crosspointer current. Refer to receiver handbook for location of this adjustment.

d. Substitute Signal Generator SG-13/ARN for the SG-2/GRM-4 and set its frequency to 332.0 mc. See A of figure 5-2 for connections.

e. Allow the SG-13/ARN to warm up for 15 minutes and red line the meter.

f. Set AUDIO SELECTOR to GLIDE SLOPE, NAV-GS Switch to GS, MICROVOLTS dial at 1000, and LOC-GS control to the center of the white segment (on course). The crosspointer current reading should be 0 ±12 microamperes.

5-8. GLIDE SLOPE 3-DB ACCURACY CHECK.

a. Perform steps a and b of paragraph 5-7.

b. Modulate the SG-2/GRM-4 with a 2-db up glide slope signal and adjust the receiver for 65 microamperes crosspointer current.

c. Perform steps d and e of paragraph 5-7.

d. Set AUDIO SELECTOR to GLIDE SLOPE, NAV-GS switch to GS, MICROVOLTS dial at 1000, and LOC-GS control to the top line of the left segment (3-db up glide slope signal). The crosspointer current should be 97.5 ±18 microamperes.

e. Repeat steps a through d above for a 3-db down glide slope signal.

5-9. Failure of the signal generator to meet the above VOR, TONE LOC, and GS accuracy requirements usually indicates that one or more of the audio signals involved is not set to the correct frequency or percentage modulation. Excessive distortion can also cause inaccuracy. Table VII lists the frequency tolerances and total harmonic distortion of the audio frequencies and VOR and r-f signal accuracies, that are permissible.

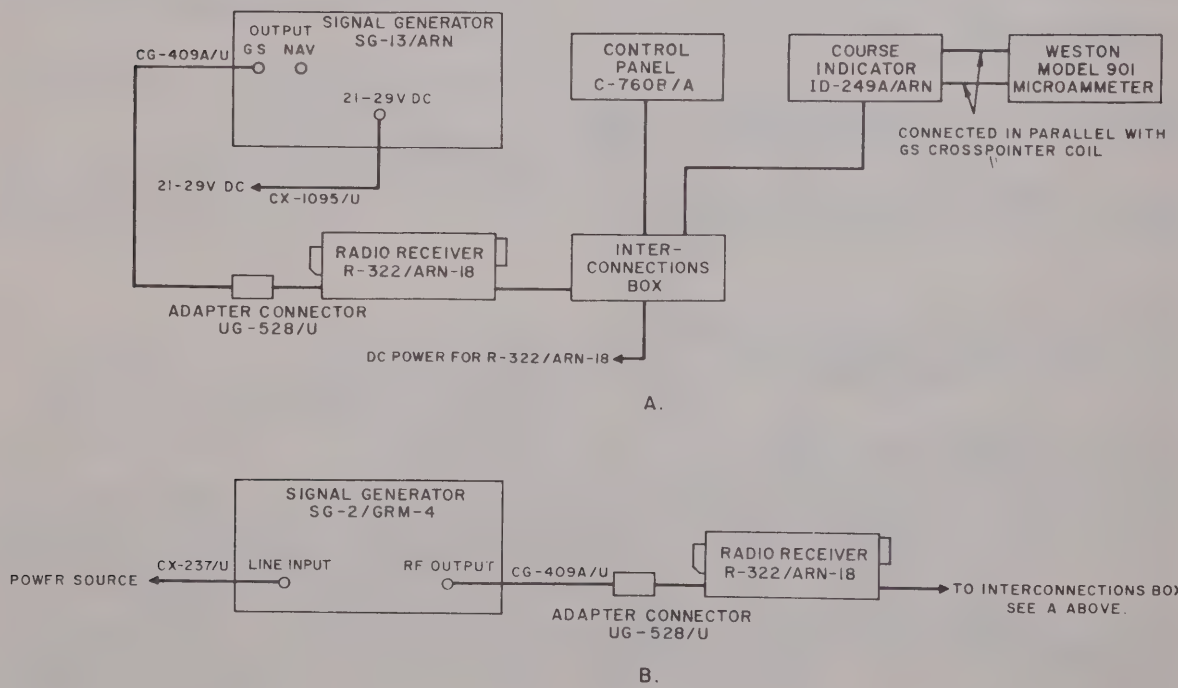


Figure 5-2. Test Setup, Glide Slope Accuracy Check

TABLE VII. MINIMUM PERFORMANCE STANDARDS

AUDIO FREQUENCY (CPS)	FREQUENCY TOLERANCE (PERCENT)	TOTAL HARMONIC DISTORTION * (PERCENT)
30	±2	6
90	±2	8
150	±2	8
1000	±20	15
9960	±3	10
Accuracy of r-f signal ±0.0065%		
Accuracy of r-f level ±30%		*Measured at pin 2, V1508.
VOR accuracy ±0.75°		

5-10. TROUBLE SHOOTING.

5-11. It is possible to detect many troubles in Signal Generator SG-13/ARN without removing the instrument from its case. The METER switch in conjunction with the meter on the front panel can be used to check for the presence of input voltage to the signal generator (LINE), +230-volt supply voltage (B+), and r-f carrier level (CAR). Audio signals can be observed with an oscilloscope or an a-c vacuum tube voltmeter connected to test point ⓐ, AUDIO OUT jack J1408. Table VIII lists probably trouble symptoms with causes and remedies.

TABLE VIII. TROUBLE SHOOTING THE SIGNAL GENERATOR

STEP	TEST POINT	CONTROL POSITIONS	NORMAL INDICATIONS	POSSIBLE CAUSE OF ABNORMAL INDICATION
1		Turn SET LINE TO 21V control from OFF. Set METER switch to LINE.	Pilot lamp lights and meter reads d-c voltage input.	Fuse F1401 or F1402. No power from power source. Connecting power cables.
2		Set METER switch to B+.	Meter indicates B+ voltage.	Dynamotor D1401.
3	ⓐ NAV OUTPUT jack J1406	Set NAV-GS switch to NAV. Set METER switch to CAR. Red line the meter with CARRIER SET control.	Meter points to red line. R-f output present at test point.	R-f chassis. Tubes V1501 through V1506. Coaxial relay K1401. Cable W1401.
4	ⓐ GS OUTPUT jack J1501	Set NAV-GS switch to GS.	R-f output present at test point.	Univerter chassis. Tubes V1510 through V1513. Cables W1501 and W1502.
5	ⓐ AUDIO OUT jack J1408	Set AUDIO SELECTOR to each of its nine positions.	Proper audio signal present at test point.	Tubes V1408, V1507 through V1509.
6	Same as step 5.	Set AUDIO SELECTOR to VOR, ϕ LOC and 9960 FM.	9960-cps signal frequency modulated by 30 cps present at test point.	No 9960-cps signal. Tubes V1406 through V1409. No 30-cps modulation: Tubes V1401 through V1403.
7	Same as step 5.	Set AUDIO SELECTOR to 30∿ VAR ϕ.	30-cps signal present at test point.	Tubes V1401 through V1403.
8	Same as step 5.	Set AUDIO SELECTOR to TONE LOC, GLIDE SLOPE, 90∿ and 150∿.	90-cps and 150-cps signals present at test point in TONE LOC and GLIDE SLOPE. 90-cps signal in 90∿ and 150-cps signal in 150∿.	No 90-cps signal: Tube V1405. No 150-cps signal: Tube V1404.
9		Perform a VOR accuracy check (paragraph 5-4).	VOR error should not exceed 0.75°.	30-cps oscillator off frequency. See Section VI, paragraph 6-44.
10		Perform tone localizer and glide slope accuracy checks (paragraphs 5-5 through 5-8).	Accuracy should meet requirements given in table VII.	Audio chassis out of alignment. See Section VI, paragraph 6-43.

5-12. MINOR REPAIR AND ADJUSTMENT.

5-13. REPLACEMENT OF TUBES.

5-14. All tubes in the signal generator are of the miniature type and are shielded. Remove the shield by pushing it down and rotating it 1/4 turn counterclockwise. Remove tube by pulling it straight out of its socket, taking care not to bend the base pins. Thoroughly test a suspected tube before discarding. If replacement does not correct operation, always reinsert the original tube. To gain access to tubes in the signal generator, proceed as follows. See figure 5-3 for tube location.

a. Loosen four fillister head captive screws on each side of the signal generator front panel.

b. Grasp the two panel handles and remove the signal generator from its case. The tubes in the audio and univerter chassis are now accessible.

c. To gain access to all the tubes in the r-f chassis, except V1501 and V1502, remove the top cover of the r-f chassis.

d. To gain access to V1502, remove the r-f chassis rear cover.

e. To gain access to V1501, remove the r-f chassis bottom cover.

CAUTION

Do not remove tubes with power applied to the equipment. Heaters are wired in various series-parallel combinations and removal of one tube may overload and burn out other heaters. See figures 4-29 and 4-30 for filament circuits.

NOTE

In the event that tubes are changed, check the associated circuit functioning for proper alignment. Univerter tube changes may considerably affect univerter alignment due to the high frequencies involved. See Section VI, paragraph 6-42 for alignment instructions.

5-15. REPLACEMENT OF FUSES.

5-16. The power input line to the signal generator is protected by two fuses mounted on the front panel. To remove, turn cap 1/4 turn counterclockwise to unlock and pull fuse from holder. If a replaced fuse blows immediately, investigate the circuits for an overload or short circuit before further replacement.

CAUTION

Never replace a fuse with one of higher rating unless continued operation is of such importance as to warrant possible damage to the equipment.

5-17. LUBRICATION.

5-18. The signal generator must be lubricated at least every 500 hours as follows:

a. Remove the signal generator from its case.

b. Remove the top and bottom covers from the r-f chassis.

c. Apply AN-G-25 grease as follows:

PART	LOCATION	AMOUNT
Dynamotor bearings.	Each end of unit.	Small amount. See section VI, paragraph 6-36.
Attenuator spur gear.	10, figure 6-10.	Small amount on gear teeth.
Attenuator plunger drive rack.	5, figure 6-10.	Small amount on top and sides.

d. Apply AN-0-4 oil as follows:

NOTE

AN-0-6A oil may be used as an alternate.

PART	LOCATION	AMOUNT
CARRIER SET control shaft bushing.	8, figure 6-5.	One drop if binding or squeaking occurs.
MICROVOLTS control shaft bushing.	7, figure 6-5.	One drop if binding or squeaking occurs.
R-f slug rack oil retaining felt washers.	8, 9, figure 6-6.	One drop.
Attenuator spur gear.	11, 12, figure 6-10.	One drop if binding or squeaking occurs.

e. Replace r-f chassis covers and secure the signal generator in its case.

5-19. INSPECTION SCHEDULE.

5-20. INTERMEDIATE INSPECTION. The overall operational check given in paragraph 5-3 and the accuracy checks given in paragraphs 5-4 through 5-8, should be performed periodically for periods not exceeding 100 hours.

5-21. MAJOR INSPECTION. Make the following inspection periodically for periods not exceeding 500 hours.

a. Remove the signal generator from its case.

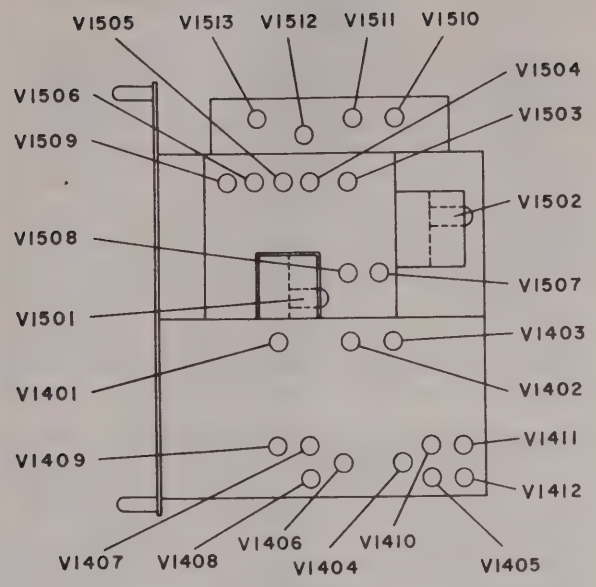


Figure 5-3. Signal Generator SG-13/ARN, Tube Location

b. Remove the top and bottom covers from the r-f chassis and clean the chassis with a soft brush or vacuum cleaner.

c. Check the signal generator and dynamotor for mechanical damage, loose parts, and signs of overheating and corrosion.

d. Check the dynamotor brushes for a minimum length of 1/4 inch. Replace if necessary. See Section VI, paragraph 6-32.

e. Check the dynamotor commutator for evidences of grooving or pitting. Dress if necessary. See Section VI, paragraph 6-31.

f. Lubricate equipment as given in paragraph 5-17.

g. Replace chassis covers and secure the signal generator in its case.

h. Perform the intermediate inspection given in paragraph 5-20.

5-22. SPECIAL INSPECTION. After each 2000-hour period of operation, replace all tubes in the equipment and perform the major inspection given in paragraph 5-21.

SECTION VI

FIELD AND FASRON MAINTENANCE

6-1. MINIMUM PERFORMANCE STANDARDS.

6-2. The minimum performance standards for Signal Generator SG-13/ARN are given in Section V, paragraph 5-1 through 5-8.

6-3. TROUBLE SHOOTING.

6-4. INTRODUCTION. For localizing troubles to a chassis or particular circuit, refer to Section V, paragraph 5-10. Once a trouble has been localized, perform the following checks and make voltage and resistance measurements to locate the faulty component. Tube locations are shown in figure 5-3.

6-5. TROUBLE SHOOTING THE R-F CHASSIS.

6-6. VACUUM TUBE CHECK. If the R-F chassis is inoperative check all its tubes. With the signal generator removed from its case and its top cover removed, apply power to the signal generator. Note whether all tubes light. Because of the series-parallel arrangement of tube filaments (figure 4-29), a burned out heater will open the heater circuit for other tubes. Tube checking can be simplified by proceeding as follows:

CAUTION

When checking tube filaments, only apply enough voltage with SET LINE TO 21V control to note whether tube filaments are lit. Do not remove tubes when the power is on. Tubes are in series-parallel arrangements and withdrawing one may damage others in the circuit.

a. If only V1501 and V1509 are lit, check filament continuity of V1508. If the V1508 filament is good, voltage dropping resistor R1555 may be open.

b. If only V1502 and V1507 are out, check these two tubes.

c. If only V1503 and V1504 are out, check these two tubes.

d. If only V1505 and V1506 are out, check these two tubes.

e. If only V1501 and V1509 are out, check these two tubes. If both V1501 and V1509 are good, voltage dropping resistor R1557 may be open.

f. If no tubes in the r-f chassis light and audio chassis tubes are operating, check continuity of r-f filter assembly by connecting an ohmmeter between test point (A1), its terminal 5, and test point (A2), terminal 3 on E1501. (E1501 is mounted on the fine frequency oscillator.)

6-7. CIRCUIT ISOLATION. After making a vacuum tube check on the r-f chassis, all tubes are found to be good yet there is no r-f output, proceed as follows:

a. Measure the voltage at test point (A), standoff E1508 (figure 6-11), at the junction of R1515 and R1516 with a d-c vacuum tube voltmeter having a 100,000-ohm resistor in series with its probe. This voltage should be greater than -1 volt over the entire frequency range of the signal generator. If this voltage is present, check r-f amplifier V1506 and the output circuit of the r-f chassis including Z1502, r-f attenuator, output coaxial cables and connectors, and coaxial relay K1401. If less than -1 volt is measured at test point (A), E1508, continue with step b below.

b. Connect the d-c vacuum tube voltmeter using a 100,000-ohm resistor in series with its probe to the control grid of each preceding stage and compare with the following typical measurements:

TEST POINT	TUBE	PIN	D-C VOLTAGE
(A3)	V1505	1	-30v
(A4)	V1504	1	12.5v
(A5)	V1503	1	-2.75v

If proper drive is present on any of these tubes and there is little or no drive on the following stage, check the tube circuit for a defective component. If little or no drive is measured on the grids of these tubes, the trouble is probably in the fine or coarse frequency oscillator.

6-8. OSCILLATOR CHECK. The drive on r-f mixer V1503 comes from both the fine and coarse frequency oscillators. To check if the coarse frequency oscillator is operating, detune T1501 by inserting the brass end of the tuning wand (1, figure 2-1) into L1511 (figure 6-11). If the coarse frequency oscillator is operating satisfactorily a d-c vacuum tube voltmeter connected in series with a 100,000-ohm resistor to pin 1 of V1503 will show a decrease in drive when T1501 is detuned. If the coarse frequency oscillator is not operating check V1502 and K1501 before removing the oscillator. Relay K1501 may be checked by listening carefully for a click each time the relay is energized and de-energized by rotating the outer knob of MEGACYCLES control. On even megacycle positions, K1501 should be energized and 21 volts dc will appear at test point (A6), terminal 2 of the coarse frequency oscillator. Both the coarse and fine frequency oscillator may be checked by placing the antenna of a receiver near the lead on terminal 1 of either oscillator and tuning the receiver to the oscillator frequency. Tables IX and X list the oscillator frequencies for all positions of the MEGACYCLES control.

TABLE IX. FINE FREQUENCY OSCILLATOR FREQUENCIES

INNER KNOB POSITION	CRYSTAL USED	FREQUENCY IN KC
.0	Y1529	4875
.1	Y1530	4900
.2	Y1531	4925
.3	Y1532	4950
.4	Y1533	4975
.5	Y1534	5000
.6	Y1535	5025
.7	Y1536	5050
.8	Y1537	5075
.9	Y1538	5100

TABLE X. COARSE FREQUENCY OSCILLATOR FREQUENCIES

OUTER KNOB POSITION	CRYSTAL USED	FREQUENCY IN KC
108	Y1501	7375.000
109	Y1502	7458.333
110	Y1503	7541.667
111	Y1504	7625.000
112	Y1505	7708.333
113	Y1506	7791.667
114	Y1507	7875.000
115	Y1508	7958.333
116	Y1509	8041.667
117	Y1510	8125.000
118	Y1511	8208.333
119	Y1512	8291.667
120	Y1513	8375.000
121	Y1514	8458.333
122	Y1515	8541.667
123	Y1516	8625.000
124	Y1517	8708.333
125	Y1518	8791.667
126	Y1519	8875.000
127	Y1520	8958.333
128	Y1521	9041.667
129	Y1522	9125.000
130	Y1523	9208.333
131	Y1524	9291.667
132	Y1525	9375.000
133	Y1526	9458.333
134	Y1527	9541.667
135	Y1528	9625.000

6-9. TROUBLE SHOOTING THE UNIVERTER CHASSIS.

6-10. VACUUM TUBE CHECK. If the univerter chassis is inoperative (no r-f output during GS operation) check all its tubes. With the signal generator removed from its case, apply power to the signal generator and note whether all four tubes on the univerter chassis light. Because of the series-parallel arrangement of tube filaments (figure 4-30) a burned out heater may open the heater circuit for other tubes. Tube checking can be simplified by proceeding as follows:

CAUTION

When checking tube filaments, only apply enough voltage with SET LINE TO 21V control to note whether tube filaments are lit. Do not remove tubes when the power is on. Tubes are in series-parallel arrangements and withdrawing one may damage others in the circuit.

a. If V1510 is not lit, check V1510 and V1404 and V1405 in the audio chassis. If V1510, V1404 and V1405 are good, resistor R1429 on the audio chassis may be open.

b. If only one filament of V1511, V1512 and V1513 are lit and the tube is good, check the r-f choke in series with the unlit filament.

c. If only V1510 is lit and the other three tubes on the univerter chassis are good, resistor R1490 on the audio chassis may be open.

6-11. CIRCUIT ISOLATION. Because of the high frequencies used in the univerter chassis, it is difficult to isolate the faulty stage by signal tracing. If all tubes in the univerter chassis are good yet there is no r-f output during GS operation, check all r-f cables and make voltage and resistance measurements to locate the faulty stage and component.

6-12. TROUBLE SHOOTING THE AUDIO CHASSIS.

6-13. WAVEFORM CHECK. Troubles in the audio chassis may be isolated to the faulty circuit by checking waveforms at test point ⏢, AUDIO OUT jack J1408, for various positions of the AUDIO SELECTOR switch. Connect an oscilloscope to the AUDIO OUT jack and compare the waveforms with those given below:

a. VOR. Appears as a wide sine wave band at 30 cps. See figure 6-1.

b. ϕ LOC. Same as VOR except smaller 30 cps amplitude. See figure 6-2.

c. TONE LOC. Appears as composite 90 and 150 cps wave which varies with LOC-GS control. See figure 6-3.

d. GLIDE SLOPE. Same as TONE LOC except that amplitude is doubled.

e. 1000∿. Appears as a 1000-cps sine wave.

f. 30∿ VAR ϕ. Appears as a 30-cps sine wave whose phase may be shifted with VOR control.

g. 9960 FM. Appears as a 9960-cps sine wave with frequency modulation spreading out the waveform. See figure 6-4.

h. 90∿. Appears as a 90-cps sine wave.

i. 150∿. Appears as a 150-cps sine wave.

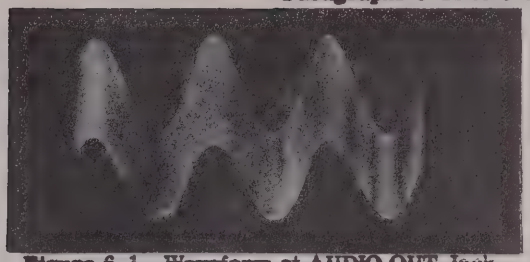


Figure 6-1. Waveform at AUDIO OUT Jack with AUDIO SELECTOR at VOR

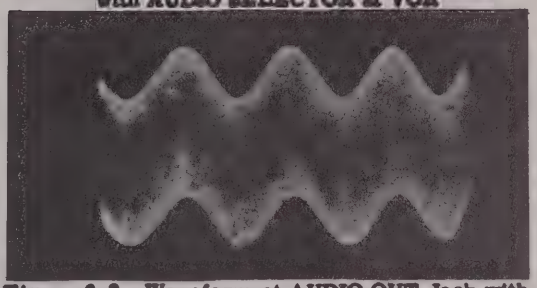
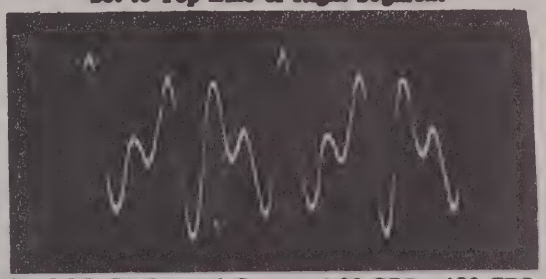
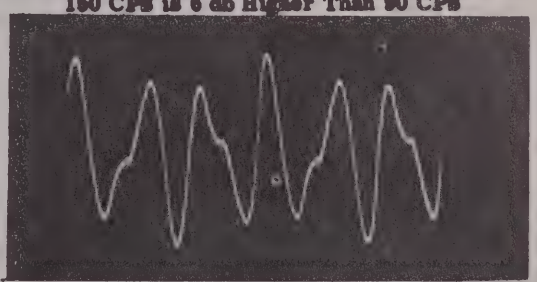


Figure 6-2. Waveform at AUDIO OUT Jack with AUDIO SELECTOR at ϕ LOC and LOC-GS Control Set to Top Line of Right Segment



A. LOC-GS Control Centered 90 CPS = 150 CPS

B. LOC-GS Control on Top Line of Left Segment 150 CPS is 6 db Higher Than 90 CPS



C. LOC-GS Control on Top Line of Right Segment 90 CPS is 6 db Higher Than 150 CPS

Figure 6-3. Waveforms at AUDIO OUT Jack with AUDIO SELECTOR on TONE LOC

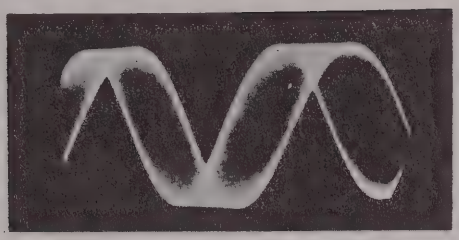


Figure 6-4. Waveform at AUDIO OUT Jack with AUDIO SELECTOR at 9960 FM

6-14. VACUUM TUBE CHECK. If the audio chassis is inoperative the tubes used in the circuit that produces the faulty audio signal should be checked. If all the audio signals are faulty, tubes used in circuits common to all audio signals should be checked. When checking for lighted tube heaters note that the filament of V1510 on the univerter chassis is in series with V1404 and V1405 heaters and therefore should also be checked when V1404 and V1405 are not lit. Table XI lists the tubes to be checked when particular audio signals are faulty or not present.

NOTE

Tubes V1506, V1507, V1508 and V1509 on the r-f chassis are common to all audio signals and should also be checked with V1408B when no audio signals appear at the AUDIO OUT jack.

6-15. VOLTAGE CHECK. After performing the waveform and vacuum tube check and the trouble is isolated to a particular circuit, isolate the trouble further by signal tracing the faulty circuit. Use a Ballantine Model 300 electronic voltmeter or equivalent and compare the measurements with the typical a-c voltages listed in table XII.

TABLE XI. TUBES USED TO PRODUCE THE AUDIO SIGNALS

AUDIO SELECTOR POSITION	AUDIO SIGNALS AT AUDIO OUT JACK	TUBES USED
VOR	9960 cps FM and 30 cps variable phase (figure 6-1).	V1401, V1402, V1406, V1408A and V1409.
ϕ LOC	9960 cps FM and 30 cps reversible phase (figure 6-2).	V1401B, V1402, V1406, V1407, V1408A and V1409
TONE LOC	90 cps and 150 cps (figure 6-3).	V1404 and V1405
GLIDE SLOPE	90 cps and 150 cps.	V1404 and V1405.
1000 $\sim$	1000 cps.	V1405 and V1407A.
30 $\sim$ VAR ϕ	30 cps variable phase.	V1401 and V1402.
9960 FM	9960 cps frequency modulated at 30 cps (figure 6-4).	V1401B, V1402, V1406, V1407, V1408A and V1409.
90 $\sim$	90 cps.	V1405.
150 $\sim$	150 cps.	V1404.

TABLE XII. TYPICAL A-C VOLTAGE MEASUREMENTS

NOTE

The following measurements were made with a Ballantine Model 300 electronic voltmeter under the following conditions: Line voltage set to 21 volts, NAV-GS switch at NAV, MEGACYCLES control on 114.9, VOR control at 0°, LOC-GS control at center position, and meter red lined with CARRIER SET control.

TEST POINT	COMPONENT	TERMINAL NO.	AUDIO SELECTOR SETTING				
			30 $\sim$ VAR ϕ	90 $\sim$	150 $\sim$	1000 $\sim$	9960 FM
B_1	V1401	6	15.0				
B_2	V1402	1	15.0				
B_3	V1402	6	15.0				
B_4	V1403	2	1.68				
B_5	V1403	7	1.68				
B_6	V1403	1	25.0				
B_7	V1403	6	25.0				
B_8	T1401	4	6.3				
B_9	T1401	7	6.3				
B_{10}	T1401	10	3.0				
B_{11}	T1401	8	3.0				
B_{12}	V1401	3	4.65				
B_{13}	V1407	7	0.27				

TABLE XII. TYPICAL A-C VOLTAGE MEASUREMENTS (Cont)

TEST POINT	COMPONENT	TERMINAL NO.	AUDIO SELECTOR SETTING				
			30∿ VAR ϕ	90∿	150∿	1000∿	9960 FM
B_{14}	Z1402	1		0.22			
B_{15}	Z1404	1			0.22		
B_{16}	V1407	3				0.68	0.55
B_{17}	V1408	1					0.42
B_{18}	V1408	7	0.06	0.03	0.03	0.06	0.09
A_7	V1507	1	0.69	0.43	0.43	0.60	0.87
A_8	V1508	7	14.8	10.5	10.5	15.5	14.2
A_9	V1508	2	12.6	8.2	8.2	13.4	13.2
A_{K}	V1506	6	7.9	5.4	5.4	8.4	8.1
⏚	J1408		0.72	0.45	0.45	0.73	0.75

6-16. TROUBLE SHOOTING THE POWER SUPPLY.

6-17. DYNAMOTOR TROUBLE SHOOTING. Troubles in the dynamotor on the audio chassis may be located by reference to table XIII.

TABLE XIII. DYNAMOTOR TROUBLE SHOOTING

SYMPTOM	PROBABLE CAUSE	REMEDY
Failure to start.	No voltage or improper input voltage.	Check source voltage.
	Open in input circuit wiring or power cable.	Check and repair open and loose connections in input circuit.
	Worn low voltage brushes.	Replace brushes.
	Dirty low voltage commutator.	If due to grease on commutator, clean with cloth saturated with gasoline or dress the commutator.
	Open armature winding.	Return dynamotor to qualified overhaul depot.
Excessive speed.	Faulty shunt field.	Return to qualified overhaul depot.
No or low output.	Dirty commutator.	Clean with cloth saturated with gasoline or dress commutator.
	Low input voltage.	Check input voltage on meter and adjust SET LINE TO 21V control for 21 volts.

TABLE XIII. DYNAMOTOR TROUBLE SHOOTING (Cont)

SYMPTOM	PROBABLE CAUSE	REMEDY
No or low output. (Cont)	Shims end loading the bearings.	Return to qualified overhaul depot.
	Faulty armature.	Return to qualified overhaul depot.
	Broken or sticking brushes.	Replace brushes.
Noisy operation.	Dry bearings.	Lubricate or replace bearings as necessary.
	Bent shaft.	Return to qualified overhaul depot.
	High commutator bar.	Return to qualified overhaul depot.
	Dynamotor mounting not secure.	Tighten mounting screws.
Overheating.	Damaged or dry bearings.	Lubricate or replace bearings as necessary.
	Shims end loading the bearing.	Return to qualified overhaul depot.
	Bent shaft rubbing against housing.	Return to qualified overhaul depot.
	Sticking brushes.	Replace or service brushes.

TABLE XIII. DYNAMOTOR TROUBLE SHOOTING (Cont)

SYMPTOM	PROBABLE CAUSE	REMEDY
Noise in signal generator output.	Arcing at brushes, broken or cracked brushes, brushes sticking in holder.	Replace or service brushes.
	High commutator bar, high mica between commutator segments.	Return to qualified overhaul depot.
	Dirty commutator.	Clean with cloth saturated with gasoline.
Vibration.	Bent shaft.	Return to qualified overhaul depot.
	Dynamotor mounting not secure.	Tighten mounting screws.

6-18. REMOVAL AND REPLACEMENT OF PARTS.

6-19. REMOVAL OF COARSE FREQUENCY OSCILLATOR. Should it become necessary to remove the coarse frequency oscillator proceed as follows:

a. Remove the top, bottom and rear covers from the r-f chassis.

b. Unsolder six leads (1, figure 6-5) connected to the terminal strip on the side of the oscillator. Label each lead as it is removed to insure proper replacement.

c. Remove three nuts (1, 2, 3, figure 6-6) which fasten the oscillator to the rear of the slug rack.

d. Slide the oscillator carefully off the slug rack shaft adapter (4, figure 6-6) and out through the opening in the rear of the r-f shield.

e. Carefully note, or record by sketching, the orientation of the slots in the rotors of the two-section wafer switch in the oscillator. Also note and record the setting of the MEGACYCLES control on the front panel.

CAUTION

Never loosen the two set screws on the coarse frequency oscillator shaft adapter for any reason other than replacement of the shaft or adapter. If these screws should be loosened accidentally or for the purpose of replacing a damaged shaft or adapter follow the procedure in paragraph 6-21 to restore the original adjustment.

6-20. REPLACEMENT OF COARSE FREQUENCY OSCILLATOR. Unless it becomes necessary to move the switch rotors while the oscillator is disassembled, the oscillator can most easily be reassembled to the slug rack by setting the MEGACYCLES control to the frequency noted in paragraph 6-19, step e, above and sliding the oscillator carefully back into place.

CAUTION

Unless care is exercised, the oscillator may be reassembled to the slug rack with the switch rotors 180° from their correct position. Refer to figure 6-7 for relative positions of the slug rack adapter and switch rotors for several different frequencies.

CAUTION

There are two switches in the oscillator. Both switch rotors must be lined up properly before inserting shaft, otherwise damage to the second switch rotor will result.

6-21. COARSE FREQUENCY OSCILLATOR SWITCH ADJUSTMENT. If the two set screws on the coarse frequency oscillator shaft adapter ever become loosened and the synchronization lost, it will be necessary to follow the procedure below to restore the original synchronization.

a. Remove rear access cover (10) and coarse frequency oscillator crystal cover (11, figure 6-6).

b. Pull out 9625.000 kc crystal, Y1528 and attach an ohmmeter between the lower socket and ground as shown in figure 6-8.

c. Set MEGACYCLES control to 135 mc.

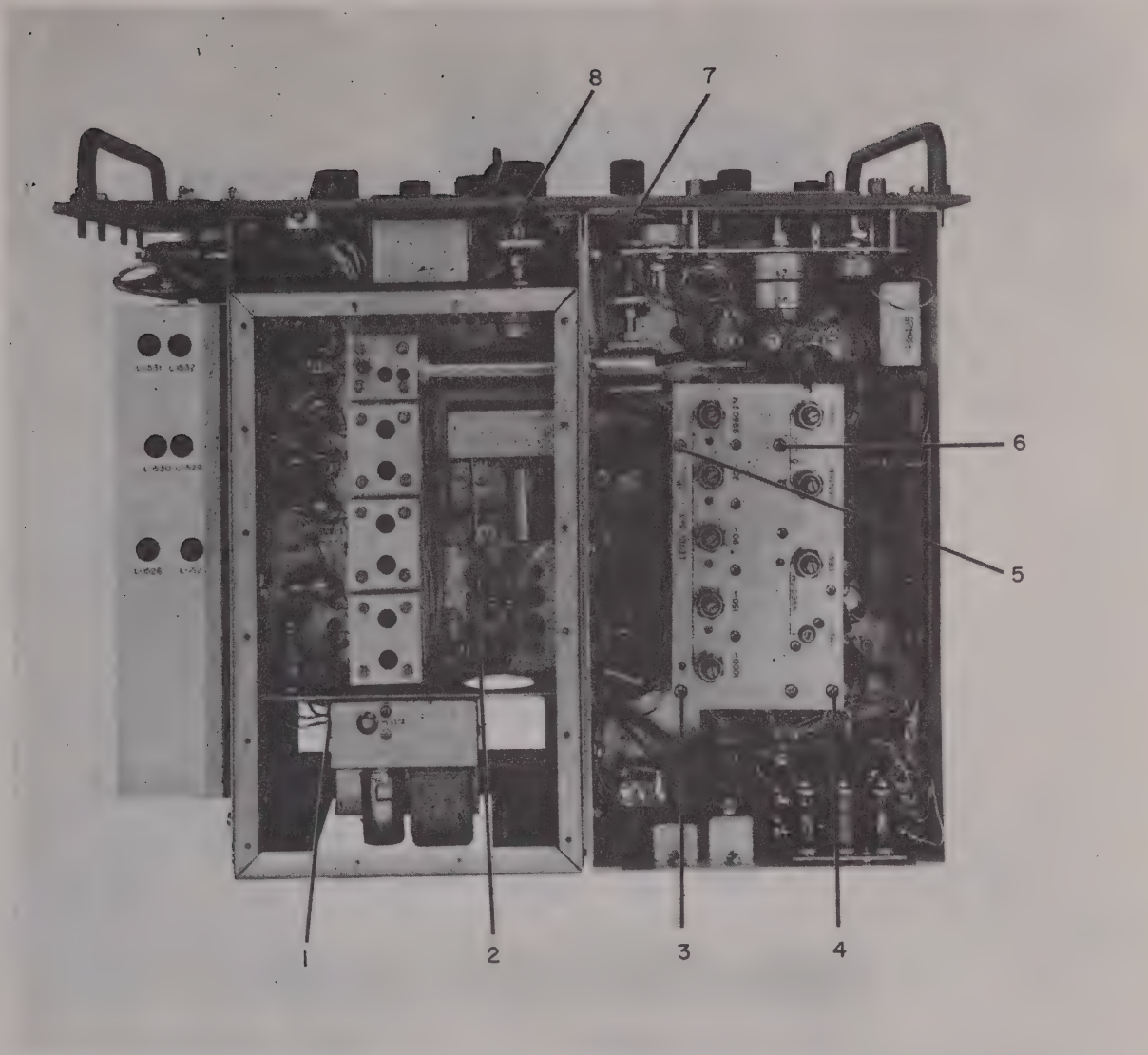
d. Loosen and turn the shaft adapter at the rear of the slug rack so that when viewed from the front of the signal generator one set screw is pointing straight out to the left and the other set screw is pointing straight up. This will closely approximate the 135 mc position.

e. Turn the adapter back and forth and note by the ohmmeter reading the approximate points at which the coarse frequency oscillator switch no longer makes contact. These points will be evidenced by the ohmmeter reading rising from 100,000 ohms to open circuit.

f. Set adapter midway between these two end points and tighten both set screws.

g. Replace crystal Y1528 and the crystal cover. Connect power to the signal generator. Turn the MEGACYCLES control from 135 to 108 and back to 135 checking the reading of the CARRIER meter at each frequency setting to make certain that normal r-f output is obtained on all channels regardless of direction of approach.

h. If good switch contact is not obtained at all frequencies, reset the MEGACYCLES control to 135 and



1 Six coarse frequency oscillator leads
2 Four fine frequency oscillator leads
3, 4, 5, 6 Potentiometer panel mounting screws
7 MICROVOLTS control shaft bushing
8 CARRIER SET control shaft bushing

Figure 6-5. Signal Generator SG-13/ARN, Bottom View

repeat steps d through g until all channels operate satisfactorily.

6-22. REMOVAL OF FINE FREQUENCY OSCILLATOR. The fine frequency oscillator may be removed by following the procedure outlined below.

a. Remove the top and bottom covers from the r-f chassis.

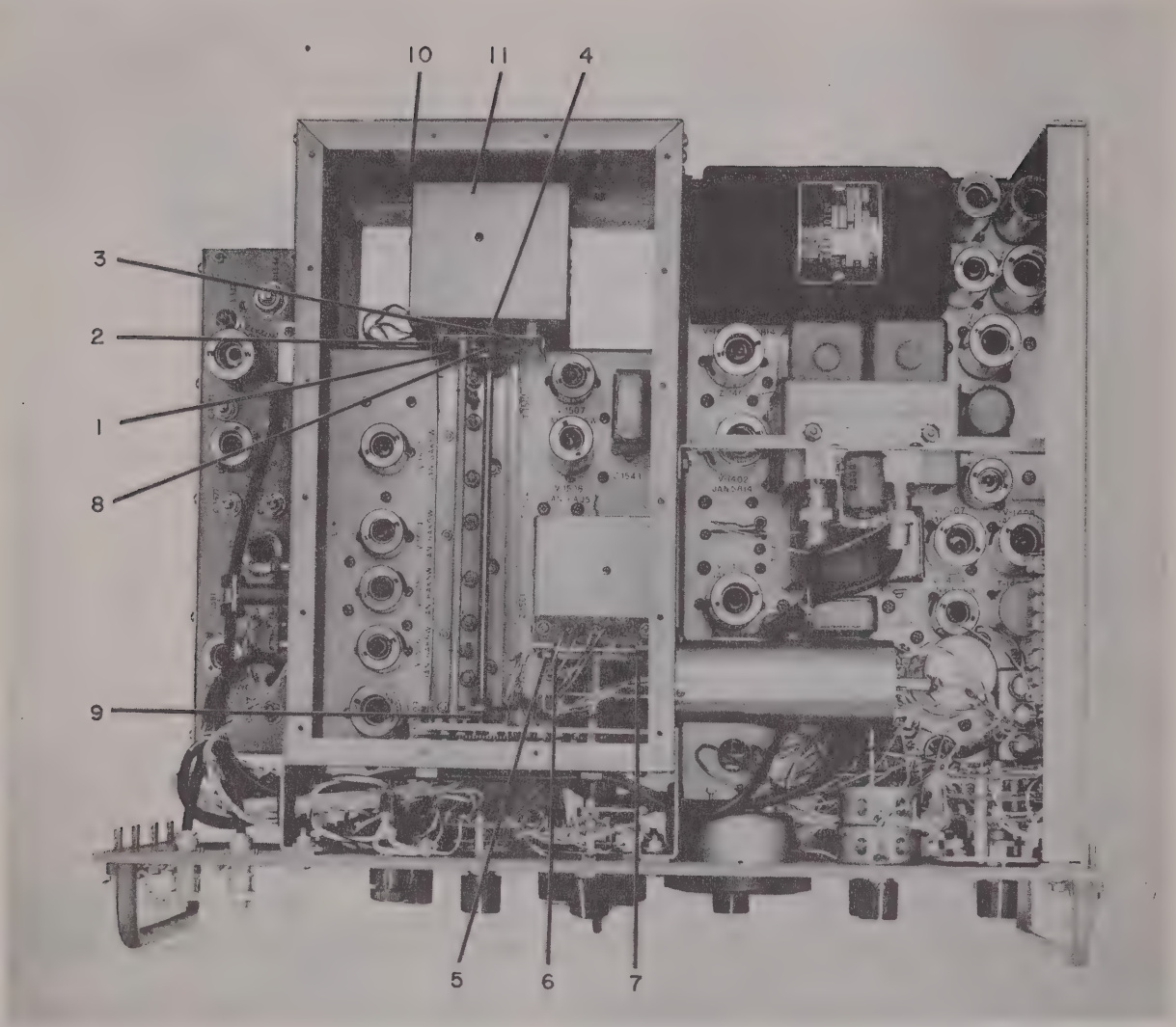
b. Remove the fine frequency oscillator tube, V1501, and its shield.

c. Unsolder four leads (2, figure 6-5) connected to the terminal strip on the oscillator.

d. Remove three nuts (5, 6, 7, figure 6-6) that fasten the oscillator to the tuner frame.

e. Carefully slide the oscillator to the rear and off the shaft and then out the top of the r-f section.

f. Note, or record by sketching, the orientation of the slot in the rotor of the wafer switch in the oscillator. Also note or record the setting of the MEGACYCLES control on the front panel.



1, 2, 3 Nuts for removal of coarse frequency oscillator
4 Coarse frequency oscillator shaft adapter
5, 6, 7 Nuts for removal of fine frequency oscillator
8, 9 Oil retaining felt washers
10 Rear access cover
11 Coarse frequency oscillator cover

Figure 6-6. Signal Generator SG-13/ARN, Top View

6-23. REPLACEMENT OF FINE FREQUENCY OSCILLATOR. Unless it becomes necessary to move the switch rotor while the oscillator is disassembled the oscillator can most easily be reassembled by setting the MEGACYCLES control to the frequency noted in paragraph 6-22, step f, above and sliding the oscillator carefully back into place.

CAUTION

Unless care is exercised, the oscillator may be reassembled with the switch rotors 180° from their correct position. Refer to figure 6-9 for relative positions for 0.2 and 0.7-mc settings of the MEGACYCLES control.

6-24. REMOVAL AND REPLACEMENT OF R-F ATTENUATOR. The attenuator may be removed by following the procedure outlined below.

a. Remove four screws (3, 4, 5, 6, figure 6-5) which fasten the large potentiometer panel to the underside of the audio chassis and lay the panel back so that no undue strain will be placed on the cable.

b. Loosen the four set screws (1, 2, 3, 4, figure 6-10) on the attenuator shaft coupler and remove the coupler.

c. Grasp end of plunger rack (5, figure 6-10) and pull out at least two inches from the attenuator tube

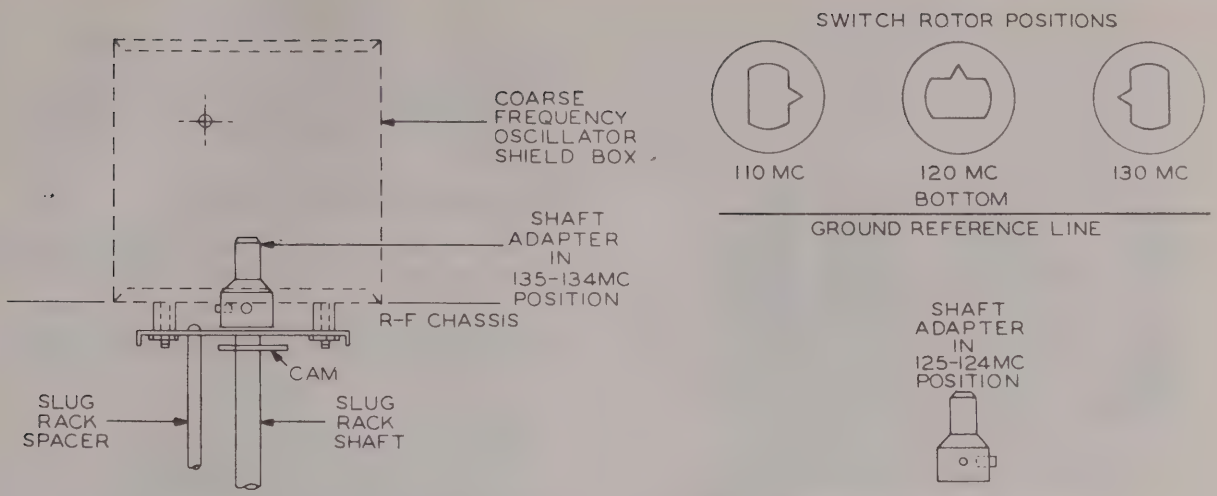


Figure 6-7. Coarse Frequency Oscillator Shaft Adapter and Switch Rotor Positions

so that the pick-up loop will not protrude from the end of the tube and sustain possible damage during removal.

d. Remove the bottom cover of the r-f chassis.

e. Loosen the set screws (6, 7, 8, figure 6-10) that secure the attenuator tube in the collar on the final r-f amplifier coil housing and the mounting bushing.

f. Slide the attenuator tube out of the collar and then carefully rotate the tube in the bushing, so that the shaft end of the assembly will clear components when withdrawn. The nuts securing two resistor stacks may have to be loosened to gain clearance.

g. Carefully slide attenuator out of the bushing. Disconnect attenuator cable from coaxial relay. Remove the UG-88/U connector from the cable.

h. When replacing the attenuator, reverse the above procedure and slide the attenuator tube through the bushing and into the collar until the panel shaft and attenuator shaft are in exact alignment.

i. Upon completing the replacement recalibrate the attenuator (paragraph 6-40).

j. If the MICROVOLTS dial does not operate smoothly the panel shaft and attenuator shaft have not been accurately aligned. Loosen set screws on collar and align shafts properly, keeping the MICROVOLTS dial at some intermediate setting to prevent damage to the pick-up loop while adjusting the attenuator tube position.

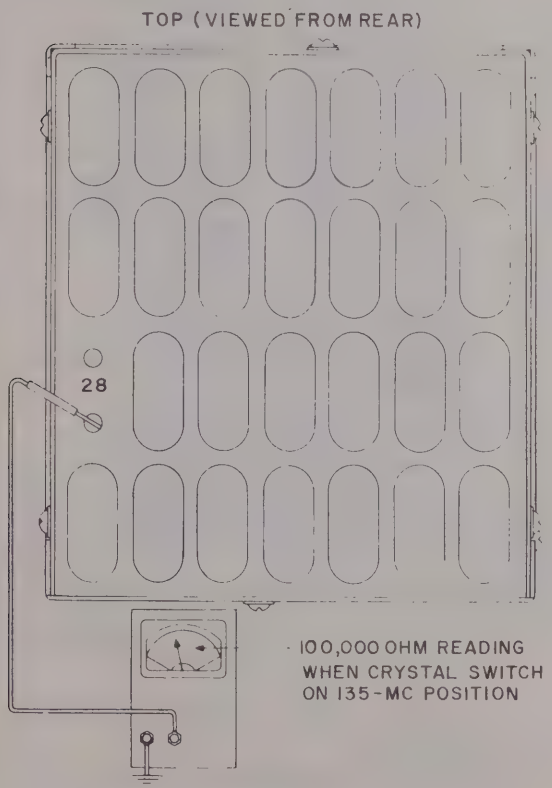


Figure 6-8. Test Setup, Coarse Frequency Oscillator Switch Adjustment

6-25. REMOVAL AND REPLACEMENT OF R-F TANK ASSEMBLIES, T1501, T1502, AND Z1501.

a. Unsolder and label the four leads entering the assembly.

b. Remove the two mounting screws accessible from the slug rack side.

c. Gently pull the assembly straight out, taking care not to damage the slugs as they are withdrawn from the assembly.

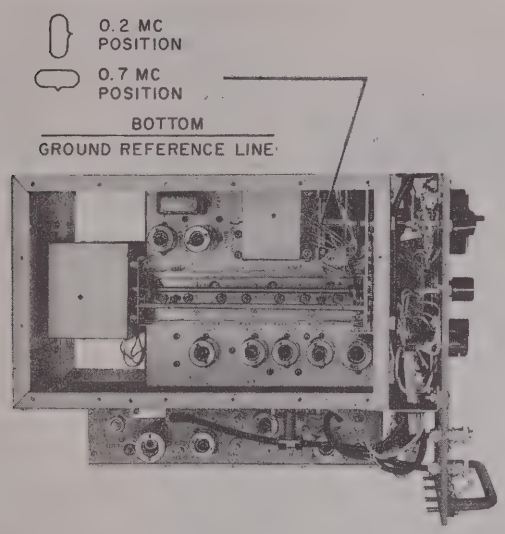


Figure 6-9. Fine Frequency Oscillator, Switch Rotor Positions

d. To gain access to parts, remove the four nuts securing the shield to the assembly. If necessary, remove the bakelite plates.

e. When replacing the assembly, reverse the above procedure, again taking care not to damage the slugs as they are reinserted into the coils.

6-26. REMOVAL OF R-F OUTPUT TANK, Z1502.

a. Uncouple and slide back the attenuator until it is clear of the collar on Z1502.

CAUTION

Do not attempt removal of Z1502 until the attenuator is well clear of the collar.

b. Remove the two nuts mounting Z1502 (accessible from the slug rack side).

c. Gently pull assembly straight out, taking care not to damage the slug as it is withdrawn from the coil.

6-27. DISASSEMBLY OF Z1502.

a. Remove the four nuts securing the shield.

b. Remove top or bottom plates only if absolutely necessary.

CAUTION

Before loosening any of the five nuts on the top of the assembly, unsolder the bottom connection on trimmer capacitor C1529 to prevent undue stress on the glass envelope and possible breakage.

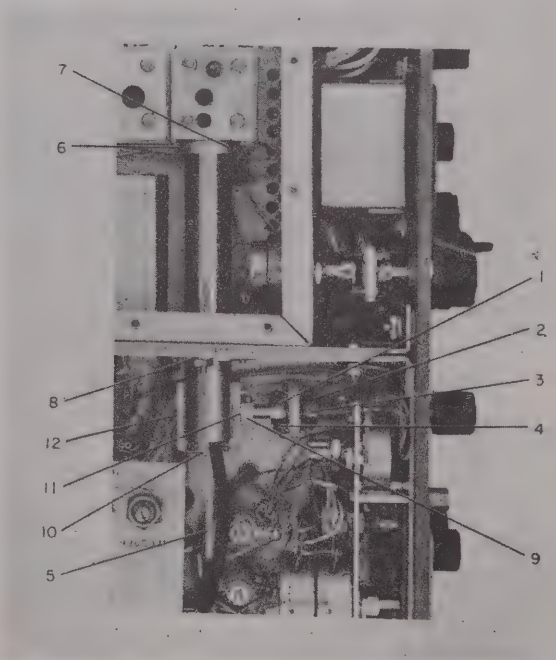
6-28. REPLACEMENT OF Z1502.

a. Reverse the procedure in paragraph 6-26, taking care not to damage the slug as it is inserted into the coil.

b. Couple the attenuator to the collar on the assembly.

NOTE

A bushing, which supports the attenuator tube, is adjusted at the factory for proper fit. Do not adjust or reposition this bushing unless the attenuator tube binds in the bushing due to improper alignment of the bushing with the collar on the Z1502 assembly. Should this condition arise, reposition the bushing by loosening the hexagon nut which secures the bushing to the chassis. Correct the alignment and secure the bushing.



1, 2, 3, 4 Set screws securing attenuator shaft coupler
5 Attenuator plunger drive rack
6, 7 Collar set screws
8 Mounting bushing set screws
9 Mechanical stop
10 Spur gear
11, 12 Spur gear shaft bushing

Figure 6-10. R-F Attenuator Mounting

c. Recalibrate the attenuator (paragraph 6-40).

6-29. REPLACEMENT OF TUNING SLUGS. In the event that the powdered iron slugs become cracked or broken, replace the slugs using the following procedure.

a. Rotate the broken slug stud clockwise until the slug and stud drop down through the hole in the top of the tank assembly.

b. Insert a new slug through this same hole and, while holding the slug stud against the movable table with a small round rod, use a screwdriver to rotate the slug counterclockwise until the threads catch.

c. Check the slug table spring tension by selecting 135 mc (the slug table in extreme upward position) and checking to be certain that the rollers are tight against the cams. They must be tight enough so that vibration will not cause the slug table to move and as a result change the positions of the slugs in the coils.

6-30. DYNAMOTOR DISASSEMBLY AND ASSEMBLY PROCEDURE. The only disassembly that should be undertaken is the removal of brushes and bearings. To disassemble this part of the dynamotor proceed as follows.

a. Disconnect the three dynamotor leads from underside of chassis.

b. Remove four screws mounting dynamotor to chassis and lift dynamotor from chassis.

c. Remove the end cover screw and pull off covers.

d. Remove fan by loosening Bristo set screws.

e. Remove screws holding the bearing retainer plates on the high and low voltage ends.

f. Remove two end bell assemblies after disconnecting the attached wires.

g. Remove ball bearing assemblies.

h. Do not disassemble the dynamotor any further.

i. To reassemble the unit, reverse the above procedure.

6-31. DYNAMOTOR COMMUTATOR DRESSING. A slight grooving of the commutators is not unusual after several hundred hours operation and may be considered as normal. If, however, it is desired to repolish the commutators, they may be polished with grade 000 or finer sandpaper.

CAUTION

Do not use emery cloth on the commutators. The abrasive is conductive and may cause short circuits in the armature by becoming imbedded in the slots between the bars.

Slight pitting can be removed by use of commutator dressing sticks of pumice grade by holding the end of the stick against the commutator face and exerting slight pressure while the dynamotor is running. This should be followed by canvas cloth polishing. If commutators are seriously worn or scored, they must be refinished by a properly equipped repair station.

6-32. DYNAMOTOR BRUSH SERVICING. Should the dynamotor brushes be binding in the brush holders, clean the brushes by wiping with a clean cloth dampened in unleaded gasoline. If this process does not correct the binding, thin the brushes down with No. 0000 sandpaper.

CAUTION

Do not allow the sandpaper to touch the contact surface of the brushes. Do not round off or chip off contact edges. Carefully remove abrasive and carbon dust.

Replace brushes that are cracked, damaged, or worn beyond the minimum length of one-fourth inch. If new brushes are installed, refer to paragraph 6-33 for brush setting procedure.

6-33. DYNAMOTOR BRUSH SEATING.

a. Place a strip of No. 000 sandpaper between the brush and the commutator, with the abrasive side facing the brush.

b. Apply only normal brush pressure. The sandpaper strip must be held snugly to the commutator so that it will have exactly the same curvature as the commutator. The strip should be drawn through in the direction of normal rotation.

CAUTION

Do not move the strip back and forth.

c. Relieve the brush pressure and repeat b above as often as is required to form the brush face to seat 75 percent in the direction of rotation and 90 percent of the width of the brush. Do not round off or chip the contact surface edge. Any loose abrasive or carbon dust should be carefully removed.

d. Following the fitting, a light application of a special brush seating stone may be used to smooth out any grooves left by the abrasive.

NOTE

After installing new brushes, the dynamotor should be run in at normal load for a few hours to obtain the polished brush surface necessary for good commutation. Noisy and inefficient operation may be experienced until the brushes are properly worn in.

6-34. CLEANING DYNAMOTOR BALL BEARINGS.

CAUTION

Ball bearings should be lubricated as soon as possible after cleaning, inspection, and testing. Never spin a ball bearing which is not lubricated. Do not handle ball bearings with fingers. Doing so may cause corrosion. Use tweezers or gloves.

Wipe the bearing with a soft, clean, lint-free cloth. Place the bearings in a clean, corrosion-resistant wire basket, and suspend the basket in a container of filtered benzene, U. S. Army Specifications No. 4-1016B. Agitate the basket to aid in flushing out the sludge. If necessary use a short bristled brush to remove the dirt. Place the bearings in a clean covered container until ready to use.

6-35. INSPECTION OF DYNAMOTOR BALL BEARINGS. Test each ball bearing by slowly rotating it. Bearings showing pronounced bumps or stickiness should be discarded and replaced. Inspect the bearings for cracks, rough or pitted surfaces, and damaged balls. The bearings should be a push fit on the armature shaft and hand tight in the housing.

6-36. LUBRICATION OF DYNAMOTOR BALL BEARINGS. Lubricate the bearings with AN-G-25 grease.

CAUTION

Do not jam the bearings full of grease. Only enough grease to fill one side of the ball race is necessary. Packing the bearings with grease will tend to cause the grease to run through the bearing seals and create excessive heat due to churning during operation.

6-37. ALIGNMENT.

6-38. INTRODUCTION. Signal Generator SG-13/ARN is carefully aligned and tested before it is shipped from the factory. The slugs and tuning capacitors are carefully adjusted at the factory and should never require more than a very slight adjustment.

CAUTION

Do not change slug positions or adjust variable capacitors except when making fine adjustments during actual alignment. Indiscriminate tuning will inevitably result in a completely misaligned instrument which will be difficult to repair.

If alignment is needed it is usually due to a change in capacitance which can be corrected by adjusting the tuning capacitor only. The tuning slugs will seldom need resetting and when they do the change necessary will be very small. The need for alignment will be indicated when it is not possible to adjust the needle on the meter to the red line when the METER switch is in the CAR position. This condition, however, can be caused by faults other than misalignment such as bad tubes or a faulty meter or metering circuit. If a unit which has been operating satisfactorily suddenly drops off in performance, it is very unlikely that misalignment is the cause.

CAUTION

When misalignment is suspected as a cause of trouble check all other logical causes of trouble before undertaking realignment.

6-39. R-F CHASSIS ALIGNMENT. Alignment of the r-f chassis of the signal generator is accomplished by following the procedure outlined below.

a. Connect Power Cable Assembly CX-1095/U or CX-1506/U to the 21VDC-29VDC connector on the signal generator and to the source of power.

b. Turn the METER switch to the LINE position and turn the SET LINE TO 21V control until the meter reads 21 ±0.5 volts.

c. Turn METER switch to B+ position and read B+ voltage on meter. Reading should be 230 volts. Allow 10 minutes warm up.

d. With METER switch to CAR position, and CARRIER SET control fully counterclockwise adjust METER ZERO control until the meter reads zero.

e. Set MICROVOLTS dial to read 1K or lower.

f. Turn MEGACYCLES control to 135.5 mc and set the meter to the red line with the CARRIER SET control if possible.

g. Connect a d-c vacuum tube voltmeter to E1508 (figure 6-11) (junction of R1515 and R1516).

h. Insert the iron end of the tuning wand into L1503, L1504, L1510, L1511, L1505 and L1506 (figure 6-11) and note any increase in d-c voltage at E1508. Insert the iron end of the tuning wand into L1508 (figure 6-11) and note any increase in output on the CAR meter. Insert the brass end of the tuning wand into the same coils and note any increase in E1508 voltage or CAR meter reading. If a circuit is properly tuned inserting either end of the tuning wand will cause the output to drop. Note the results but do not make any adjustments. It will be noted that the tuning of the last two coils toward the front of the r-f chassis is much more critical than the tuning of the preceding stages.

i. Repeat step h at 108.5 megacycles.

j. Measure the d-c voltage at E1508 as the MEGACYCLES control is rotated over the entire range. If the alignment is good the voltage will be at least -1.0 volt for any frequency. This is an overall check of all tuned circuits except the final circuit, Z1502.

k. If the above steps indicate the need for alignment, continue with step 1, below. The final tank circuit, Z1502, is the one most likely to require alignment. In most cases a slight adjustment of C1529 (figure 6-11) is all that is required.

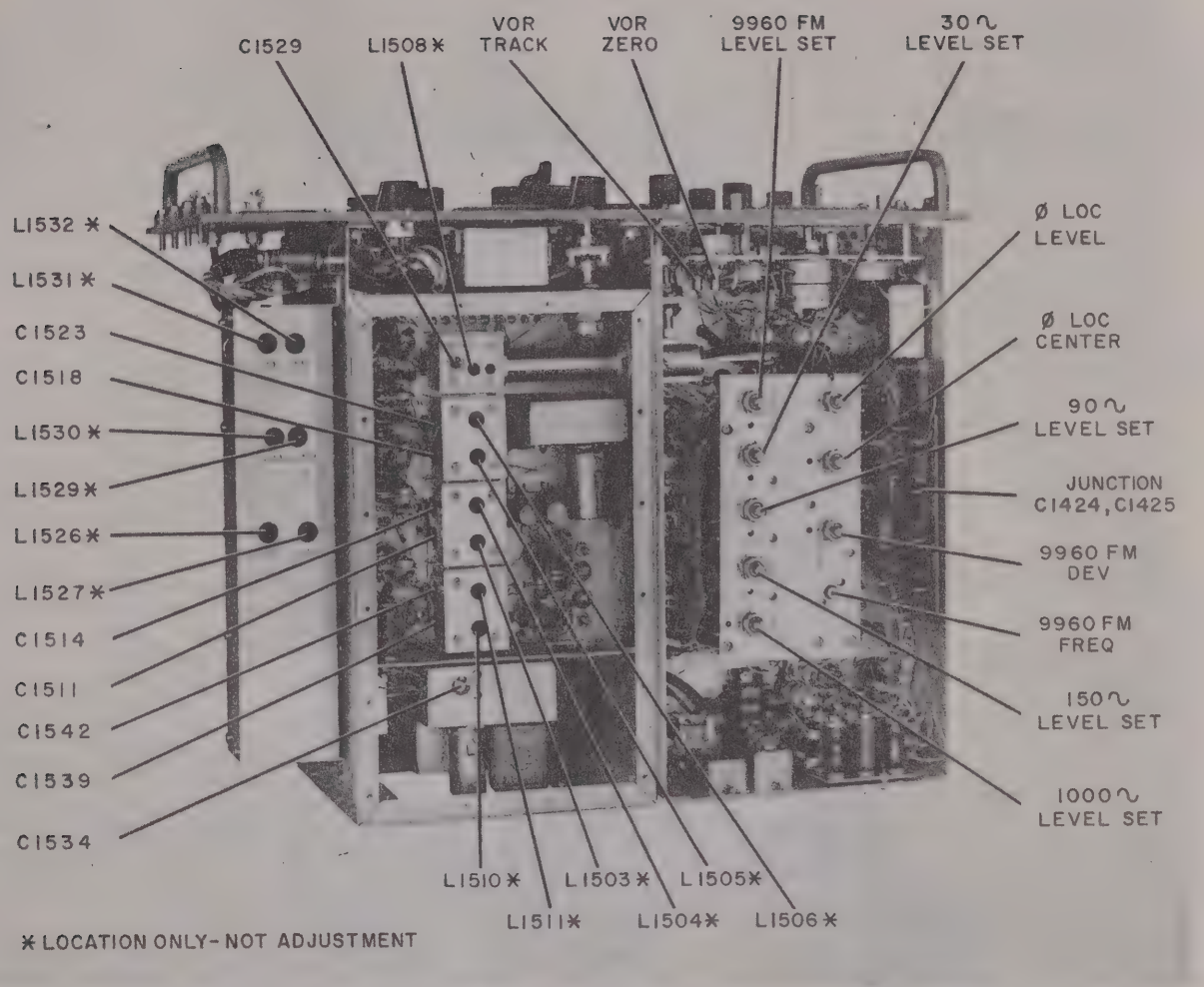


Figure 6-11. Signal Generator SG-13/ARN, Bottom Chassis Alignment Points

l. Turn MEGACYCLES control to 135.5 and check for proper tuning of Z1502 with the tuning wand. If inserting either end into L1508 increases the output as read on the meter in the CAR position, tune C1529 on the final tank Z1502, for a maximum on the meter. (See figure 6-11.) The brass end of the tuning wand serves as an adjusting tool. Only a slight change in tuning capacitance should be necessary.

CAUTION

Indiscriminate tuning of the capacitor to its extreme maximum and minimum settings is unnecessary and may result in damage to the capacitor.

Recheck the tuning with the tuning wand.

m. Turn MEGACYCLES control to 108.5 and check for resonance with the tuning wand as in step h. If the circuit is not in resonance adjust the L1508 slug in Z1502. This adjustment is on the slug rack on top of the chassis. (See figure 6-12.)

n. Repeat steps l and m above until the circuit is in tune at both ends. Slugs are always adjusted at 108.5 mc and the trimmer capacitors at 135.5 mc. If the voltage on E1508 is greater than -1.0 volt over the entire frequency range, further alignment is unnecessary. If further alignment is required, continue with step o below.

o. Connect a d-c vacuum tube voltmeter to E1508 to measure the output of quadrupler V1505. Tune to 135.5 mc and check each coil in Z1501 (L1505 and L1506) for resonance. Adjust the trimmers on the side of Z1501 (C1518 and C1523) if necessary using the right angle screwdriver provided. (See figure 6-11.)

p. Tune to 108.5 mc and check for resonance. Adjust the L1505 and L1506 slugs in Z1501 if necessary. (See figure 6-12.)

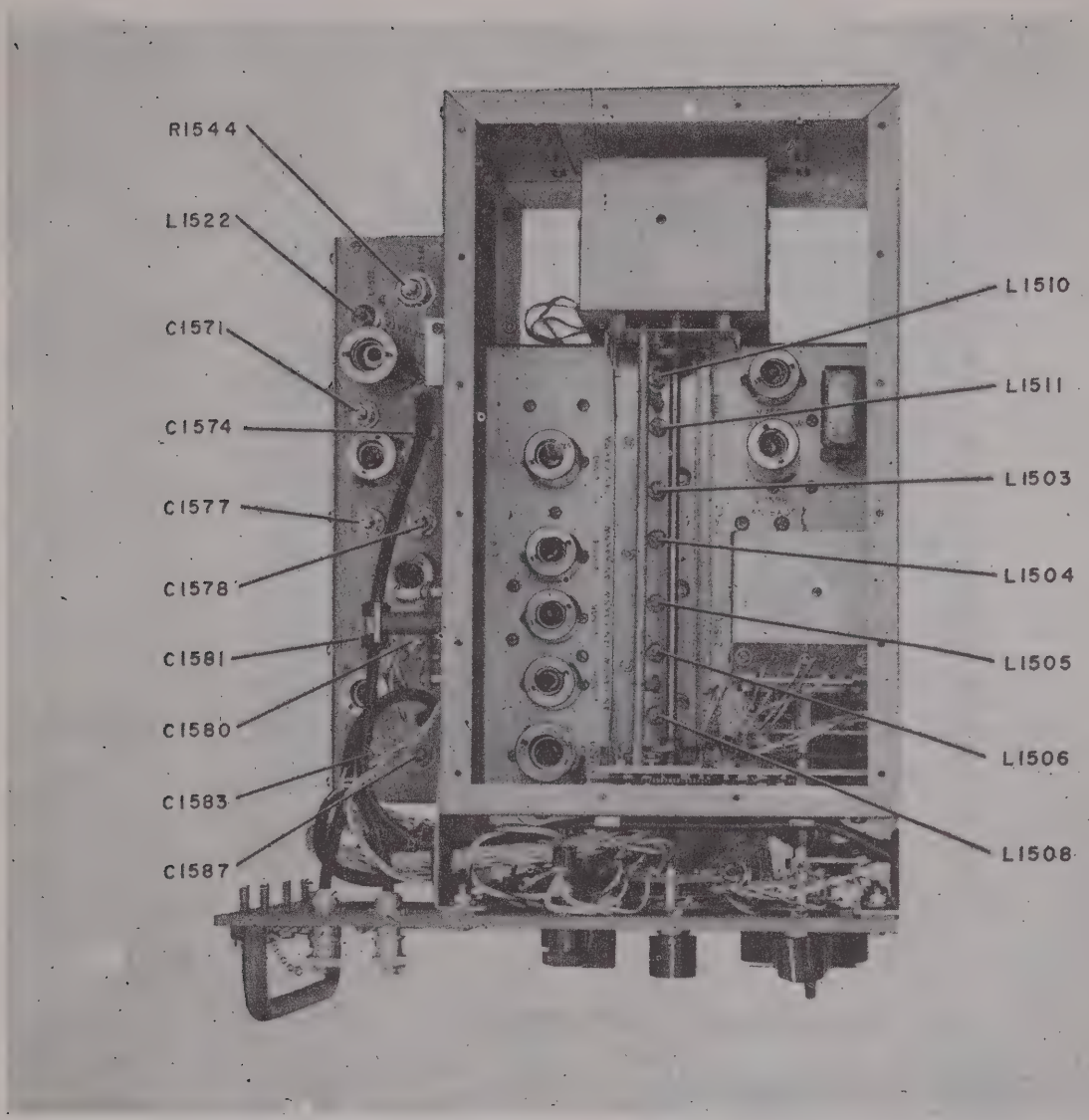


Figure 6-12. Signal Generator SG-13/ARN, Top Chassis Alignment Points

q. Repeat steps o and p until the tuned circuits are in resonance at both ends.

r. Adjust mixer coils in T1502 (L1503, L1504) by tuning to 135.5 mc and inserting the iron end of the tuning wand in one coil until the circuit is detuned and the voltage on E1508 falls to a low value Adjust the trimmer on the other coil for maximum output. Repeat this procedure for the other mixer coil.

s. Tune to 108.5 mc and repeat procedure of step r.

t. Tune the coarse frequency oscillator output coils in T1501 (L1510, L1511) in the same manner as the mixer (steps r and s above).

u. The coarse frequency oscillator employs a frequency adjusting trimmer, C1534 (figure 6-11), which is adjusted at the factory and should not require any further attention unless changes are made in the components or wiring in the grid circuit of V1502. In this event, measure the frequency of the oscillator using each of the 28 frequencies. Make these measurements with a secondary frequency standard having an accuracy of ±0.001 percent. See table X for crystal frequencies. A small pick-up loop inserted in the T1501 coil nearest the coarse frequency oscillator (L1510) will provide enough pick-up to permit measurement of the 7375-9625-kc signals. Rotate the MEGACYCLES control to each of the 28 positions and measure each of the 28 crystal frequencies. All should be accurate

within ±0.0065 percent. If any of the crystal frequencies are found to be more than 0.0065 percent in error it will usually be found that all the other frequencies are in error in the same direction. A slight adjustment of C1534 at the bottom of the coarse frequency oscillator should shift all the crystal frequencies so that none will fall outside the ±0.0065 percent limits. If any crystal still falls outside these limits insert a new crystal to obtain required frequency.

6-40. R-F ATTENUATOR ALIGNMENT.

a. Place all covers on the r-f chassis and tighten all cover screws securely. This is necessary to prevent r-f leakage during alignment.

b. The r-f output is adjusted by comparing it with the output of a Signal Generator SG-1/ARN. Feed a 114.9 mc signal from Signal Generator SG-1/ARN into an AN/ARN-14 navigation receiver with a d-c vacuum tube voltmeter connected to measure the receiver avc voltage. Use a 53-ohm 6-db pad in the cable connecting the receiver to the SG-1/ARN to keep the standing wave ratio low. See figure 5-1 for test connections.

c. Set Signal Generator SG-1/ARN MICROVOLTS dial to 500 microvolts and note avc voltage developed in the receiver.

d. Substitute Signal Generator SG-13/ARN for the SG-1/ARN using the same 6-db pad and adjust the MICROVOLTS dial until the same avc voltage reading is obtained. Adjust METER ZERO. The CARRIER SET control should be adjusted to the red line prior to this measurement. The MICROVOLTS dial should read 1000. If not, loosen the dial set screws with the Bristo wrench furnished and reset.

NOTE

The SG-1/ARN microvolts dial is calibrated for use with a 6 db pad. The SG-13 microvolts dial is calibrated for a direct connection between NAV or GS output connectors and receiver input.

A 53-ohm 6 db pad is used with the SG-13/ARN output cable in this test only to insure proper termination of the SG-13/ARN in case the receiver being used does not have exactly 53-ohms input impedance. For this reason, the SG-13/ARN MICROVOLTS dial must be set to twice the reading of the SG-1/ARN microvolts dial during this alignment procedure.

CAUTION

Take care to allow the signal from only one signal generator to get into the receiver while measuring the avc voltage. Adjust the signal generator not in use to some other frequency while making measurements.

e. Turn the SG-13/ARN MICROVOLTS dial to a maximum. This should give 200,000 microvolts which is comparable to a 100,000 microvolt setting on Signal Generator SG-1/ARN. If sufficient SG-13/ARN output cannot be obtained, reset the stop on the attenuator shaft (9, figure 6-10). With this stop set for a maximum output of 200,000 microvolts the attenuator dial will usually indicate that value with little error.

CAUTION

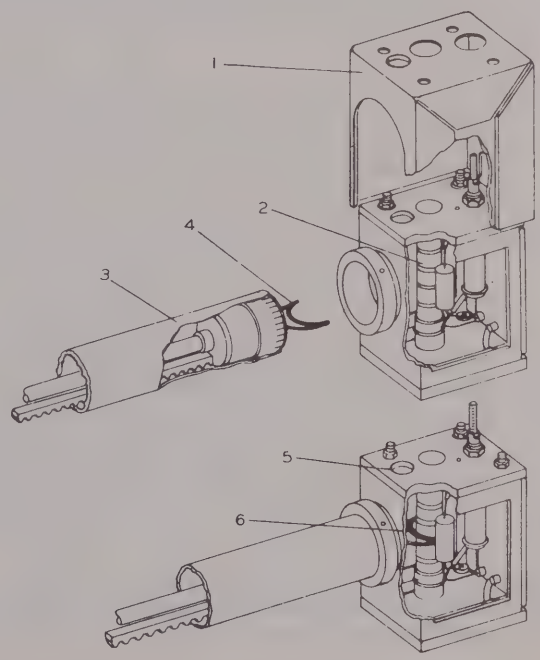
Use extreme care in turning the attenuator dial while the stop is being adjusted. If the dial is turned too far, the U-shaped pick-up loop in the attenuator may strike the final tank coil and be damaged. This is usually evidenced by the CAR meter reading dropping to zero at the highest setting of the MICROVOLTS dial.

6-41. The position of the pick-up loop with respect to the coil at the maximum setting of the MICROVOLTS dial may be checked as follows. Refer to figure 6-13.

a. Remove the bottom r-f shield cover.

b. Remove the four nuts and shakeproof washers on the top of Z1502 and pull off the shield can (1).

c. Shine a light through the hole (5) on top of the housing and note the clearance (6) between the loop (4)



1 Shield can for Z1502 assembly
2 Final r-f tank coil L1508
3 Attenuator removed from collar
4 Pick-up loop
5 Inspection hole
6 Point of normal 1/32 to 3/64 inch clearance with MICROVOLTS set to maximum

Figure 6-13. R-f Output Coupling Assembly

and coil (2) with the MICROVOLTS dial set to its maximum output position. This clearance will normally be 1/32 to 3/64 inch. If the loop touches L1508 at any point, insert a small screwdriver through the hole and very carefully bend the loop until it centers properly. Repeat steps in paragraph 6-40 above.

6-42. UNIVERTER CHASSIS ALIGNMENT.

NOTE

Use a non-metallic screwdriver to adjust L1522 and all variable capacitors located in the univerter.

a. Install the univerter cover and all r-f covers before alignment. Be sure the covers are properly seated and screws tightened securely.

b. Set NAV-GS switch on GS, MEGACYCLES dial on 332.0, and connect the GS output to the input jack of an AN/ARN-18 glide slope receiver through a 53-ohm 6-db pad (UG-528/U). See figure 5-2. Adjust METER ZERO and set carrier level to the red line on the meter.

c. Connect a d-c vacuum tube voltmeter between L1530 and ground. (L1530 is accessible through the hole in the univerter cover as shown in figure 6-11. Make test connections by placing meter lead on any part of the turns in the coil.) Tune L1522 (figure 6-12) for a peak reading on the vacuum tube voltmeter.

d. Measure the receiver avc voltage with a d-c vacuum tube voltmeter and adjust the MICROVOLTS dial to a level just high enough to give a small avc voltage. In cases of extreme misalignment, it may be necessary to advance the setting of R1544 in a clockwise direction to obtain an indication of avc voltage. Adjust C1571 and C1574 for maximum output as indicated by the receiver avc voltage. See figure 6-12.

e. Tune the overcoupled tuned circuits between the mixer and the first amplifier as follows. Short any two adjacent turns of L1527 together by inserting a small metallic screwdriver through the hole in the bottom cover of the univerter and tune C1577 for maximum avc voltage. (If the avc voltage falls too low when the coil is shorted, increase the setting of the MICROVOLTS dial.) Then short L1526 and tune C1578. When tuning overcoupled circuits, it is always necessary to detune one side by shorting turns to tune the other side properly.

g. In the same manner, short L1530 and tune C1580, short L1529 and tune C1581, short L1532 and tune C1583, and short L1531 and tune C1587.

h. Check the univerter output to make sure it is uniform within ±15 percent over the frequency range 329.3 to 335.0 mc. This can be done by checking Signal Generator SG-13/ARN against an SG-2 signal generator. Set the SG-2 MICROVOLTS dial at 500 and feed a 332-mc signal into an AN/ARN-13 glide slope receiver through a 53-ohm 6-db pad (Adapter UG-528/U). See figure 5-2. Note the receiver avc voltage. Substitute SG-13/ARN for the SG-2, using the same frequency setting and 6-db pad with the MICROVOLTS dial set at 1000. (Use GS output connector.) Adjust R1544 (figure 6-12) on the univerter to duplicate the avc reading noted above.

i. Check the univerter output as follows to insure that the response is sufficiently flat from 329.3 to 335.0 mc. Set SG-13/ARN MEGACYCLES control to 329.3 and MICROVOLTS dial to 1000. Feed the output into an AN/ARN-18 receiver through Adapter UG-528/U and note the receiver avc reading. Substitute SG-2 for SG-13/ARN and duplicate the avc reading by adjusting the SG-2 output. The SG-2 output should be within ±15 percent of 500 microvolts. Make similar comparisons at 331.1, 332.0, 332.9 and 335.0 mc. If the 15 percent requirement is not met, readjust C1583 and/or C1587 slightly to correct any peaks or dips in the response and repeat the entire procedure outlined in paragraphs h and i above.

6-43. AUDIO CHASSIS ALIGNMENT. All audio adjustments must be made with the r-f covers on and all cover screws securely tightened. Set the SG-13/ARN MICROVOLTS dial at 1000 and the NAV-GS switch in the NAV position unless otherwise specified. Adjust for 21 volts line on the panel meter and allow 10 minutes warm-up period before making any adjustments. Tighten locking nuts on controls as each adjustment is completed.

6-44. FREQUENCY ADJUSTMENT.

a. Connect the vertical input of an oscilloscope to the AUDIO OUT connector located behind access plate on the front panel and set AUDIO SELECTOR to 30∿ VAR ϕ. Adjust METER ZERO and set carrier to red line. Connect a 60 cps power line frequency or an accurate frequency standard to the horizontal input of the oscilloscope.

b. Set the 30∿ FREQUENCY control behind the access cover on the front panel to exactly 30 cps by adjusting until the proper Lissajous pattern is obtained. This will be a double loop if the 60 cps power line frequency is used. Adjust until this double loop is stationary.

c. Rotate AUDIO SELECTOR to 9960 FM position and set 9960 FM DEV control for zero deviation. Adjust the 9960 FM FREQ control to a frequency of 9960 cps as measured at the AUDIO OUT connector with an oscilloscope and accurately calibrated a-f oscillator using Lissajous patterns. These controls are located on the potentiometer panel (figure 6-11). The oscillator is very stable and should seldom need resetting. If the frequency is lower than 9960 cps at all settings of the 9960 FM FREQ control, remove the white-orange jumper wire used to connect C1437 in parallel with C1434. If the frequency is higher than 9960 cps at all settings of the 9960 FM FREQ control, connect a jumper wire to place C1437 in parallel with C1434. These capacitors are located on the underside of the potentiometer panel and accessible only when the panel is pulled back. Points A and B (figure 6-14) show the jumper connecting points.

d. Rotate AUDIO SELECTOR to 1000∿ position and adjust 1000∿ FREQUENCY control behind the access

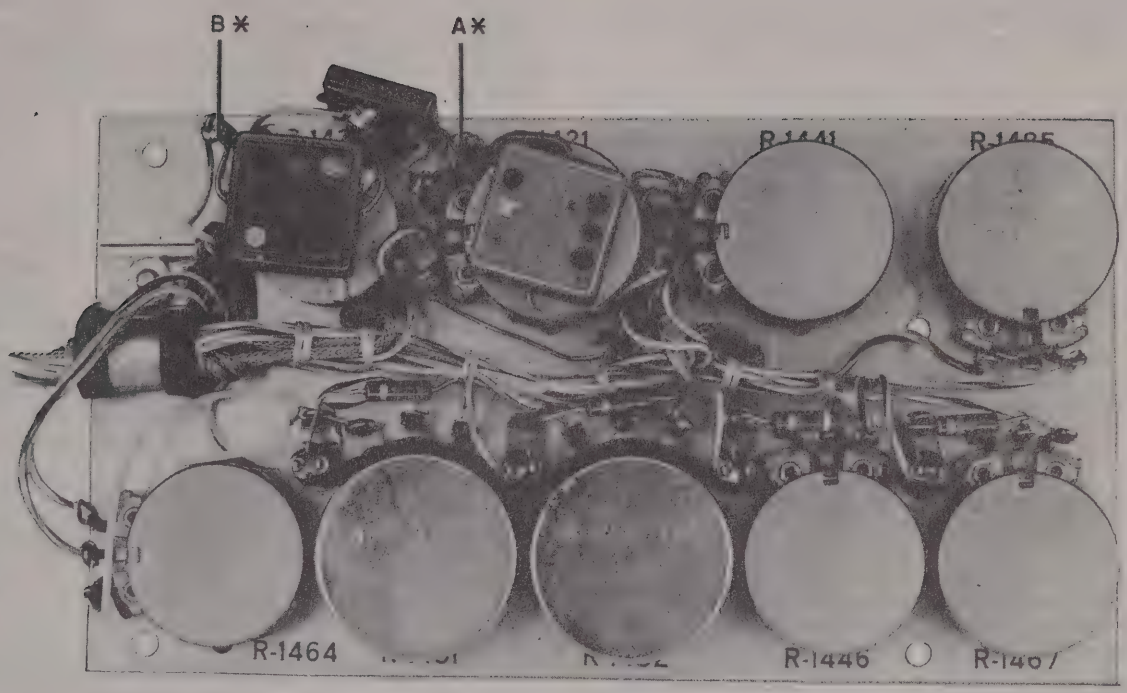


Figure 6-14. Potentiometer Panel Assembly, Rear View

cover on the front panel to obtain an oscillator frequency of 1000 ±200 cps as measured with an oscilloscope and audio oscillator using Lissajous patterns.

6-45. MODULATION PERCENTAGES. The modulation levels can be adjusted with the test setup shown in figure 5-1. The modulation levels are stable and will seldom need resetting. A substitution method is used to set the audio levels on Signal Generator SG-13/ARN. A signal from Signal Generator SG-1/ARN and Modulator MD-83A/ARN is fed into a navigation receiver. The avc and detector audio voltages of the receiver are noted. A similar signal from Signal Generator SG-13/ARN is then applied to the receiver and the levels adjusted to repeat the noted readings. In all the alignment procedures that follow a 53-ohm 6-db attenuator pad is used between the r-f cable from the SG-13/ARN to the input connector of the navigation receiver. In all of the following procedures the r-f output cable is connected to the NAV OUTPUT connector and the NAV-GS switch must be in the NAV position.

6-46. 30 CPS MODULATION LEVEL.

a. Set up Signal Generator SG-1/ARN to read 500 microvolts at 110.1 mc and modulate it with 30 cps at 30 percent modulation as read on the SG-1/ARN modulation meter.

b. Connect this signal into the navigation receiver and read the 30 cps voltage developed at the receiver detector with an a-c vacuum tube voltmeter. Also read the receiver avc voltage with a d-c vacuum tube voltmeter.

c. Substitute Signal Generator SG-13/ARN for Signal Generator SG-1/ARN and Modulator MD-83A/ARN. Adjust SET LINE TO 21V, METER ZERO and CARRIER SET controls. Adjust the MICROVOLTS dial until the same receiver avc voltage is obtained as in step b above. The MICROVOLTS dial should read approximately 1000 microvolts.

d. With the AUDIO SELECTOR on the 30∿ VAR ϕ position, adjust the 30∿ LEVEL SET control (figure 6-11) until the same 30 cps detector voltage is obtained as in step b. Lock the 30∿ LEVEL SET control.

6-47. 9960 FM MODULATION LEVEL. With the AUDIO SELECTOR in the 9960 FM position set the 9960 FM LEVEL SET control (figure 6-11) to 30 percent modulation using the same procedure as described in paragraph 6-46, above.

6-48. 1000 CPS MODULATION LEVEL. With the AUDIO SELECTOR in the 1000∿ position, adjust the 1000∿ LEVEL SET control (figure 6-11) to 30 percent

modulation using the same procedure as described in paragraph 6-46 above.

6-49. 90 CPS AND 150 CPS MODULATION LEVELS AND TONE LOCALIZER CENTERING.

a. Set the AUDIO SELECTOR in the 90∿ position. Connect an ohmmeter scaled to read in the vicinity of 10,000 ohms between the center terminal of R1418A and ground. (R1418A is the front section of the dual LOC-GS potentiometer.) Rotate the LOC-GS control until the resistance reading is at a maximum. Loosen the knob of the LOC-GS control and position it on the shaft so that the knob points to the middle of the white center sector on the panel. Tighten the knob set screws carefully with the knob set in this position.

b. With the AUDIO SELECTOR still in the 90∿ position and the LOC-GS control set to the middle of the white center sector, adjust the 90∿ LEVEL SET control (figure 6-11) to 20 percent modulation using the procedure of paragraph 6-46.

c. Connect the Ballantine Model 300 electronic voltmeter to the AUDIO OUT connector and read the 90 cps voltage.

d. Without changing the setting of the LOC-GS control, rotate the AUDIO SELECTOR to 150∿ position and adjust the 150∿ LEVEL SET control (figure 6-11) to obtain the same voltage at the AUDIO OUT connector as read in step a, above, for 90 cps.

6-50. TONE LOCALIZER 6 DB TO 7.5 DB SECTOR ADJUSTMENTS. The zero db adjustments in paragraph 6-49 above must be made before the procedure below is undertaken.

a. Connect an a-c vacuum tube voltmeter to the AUDIO OUT connector on Signal Generator SG-13/ARN. Adjust SET LINE TO 21V, METER ZERO and CARRIER SET controls.

b. Loosen the two front panel screws that lock the two sectors on the LOC-GS control. Rotate the LOC-GS control to the right until the 90 cps voltage as read at the AUDIO OUT connector, with the AUDIO SELECTOR on the 90∿ position, is twice the 150 cps voltage as read at the same point with AUDIO SELECTOR on 150∿ position. When the setting of the LOC-GS control is obtained that gives a 2 to 1 ratio of voltages, move the right hand sector until the top engraved line on the sector is aligned with the center line on the knob. Hold the sector so it cannot move and turn the knob aside and tighten the screw to lock the sector in this position.

c. Use the same procedure to set the left hand sector. At this position the 150 cps voltage must be twice the 90 cps voltage for the proper setting of the sector. Use extreme care in making these sector adjustments. The glide slope and phase localizer operation depends upon these adjustments.

6-51. GLIDE SLOPE 0 DB AND 3 DB TO 3.75 DB ADJUSTMENTS. The glide slope is automatically adjusted when the tone localizer adjustment is made. It requires no additional setting of controls. These db adjustments may be checked at the AUDIO OUT connector by turning the AUDIO SELECTOR to GLIDE SLOPE and grounding the grid of the 150 cps stage (V1404, pin 2) while reading the 90 cps voltage; then grounding the grid of the 90 cps stage (V1405, pin 2) while reading the 150 cps voltage. The voltage ratios obtained with the LOC-GS control set at the top line of each sector will be 1.41 to 1 instead of 2 to 1.

6-52. 9960 FM DEVIATION RATIO.

a. Set up Signal Generator SG-1/ARN to read 500 microvolts at 114.9 mc and modulate it at 30 percent with the 9960 FM signal from Modulator MD-83A/ARN.

b. Connect this signal into the navigation receiver and read the avc voltage with a d-c vacuum tube voltmeter. Also read the 30 cps voltage at the discriminator with a Ballantine Model 300 electronic voltmeter.

c. Substitute Signal Generator SG-13/ARN for Signal Generator SG-1/ARN. Adjust SET LINE TO 21V, METER ZERO, and CARRIER SET controls. With the AUDIO SELECTOR in the 9960 FM position adjust the MICROVOLTS dial until the same receiver avc voltage is obtained as in step b above.

d. Adjust the 9960 FM DEV control to obtain the same discriminator voltage as was read in step b above.

6-53. VOR ZERO ADJUSTMENT. The 30∿ FREQUENCY, 9960 FM FREQ, 9960 FM DEV, 30∿ LEVEL SET and 9960 FM LEVEL SET controls must be adjusted before beginning the following procedure.

a. This adjustment and the following VOR tracking adjustment require the use of Indicator ID-249A/ARN and an accurate zero reading microammeter connected across the vertical (omni) crosspointer. (See figure 5-1.) The AN/ARN-14 crosspointer output is designed for a 333-ohm load. The Weston Model 901 microammeter has a 1000-ohm movement as do the ID-249A/ARN crosspointer movements. To obtain the necessary 333-ohm load in this test setup, the glide slope crosspointer must be paralleled with the omni-crosspointer.

b. Set up Signal Generator SG-1/ARN to read 500 microvolts at 114.9 mc and modulate it at 30 percent with the VOR signal from Modulator MD-83A/ARN. Connect output of Signal Generator SG-1/ARN to input of the navigation receiver.

c. Set the PHASE ANGLE SELECTOR on Modulator MD-83A/ARN to 0° and adjust the SET control on Indicator ID-249A/ARN until the microammeter reads zero (centered). Do not change this setting of the SET control. Read the receiver avc voltage with a d-c vacuum tube voltmeter.

d. Substitute Signal Generator SG-13/ARN for Signal Generator SG-1/ARN and Modulator MD-83A/ARN. Set MEGACYCLES dial to 114.9 mc and adjust CARRIER SET control for red line indication.

e. Adjust the MICROVOLTS dial to duplicate the avc voltage read in step b above. Dial will read approximately 1000 microvolts.

f. With AUDIO SELECTOR in VOR position and the VOR switch in 0° position adjust VOR ZERO control (figure 6-11) until the microammeter is again centered. The TO-FROM indication will be TO.

6-54. VOR TRACKING ADJUSTMENT. The VOR tracking adjustment must be preceded by the VOR ZERO adjustment. Carry out adjustments given in paragraph 6-53 above before beginning procedures below.

a. Set up Signal Generator SG-1/ARN to read 500 microvolts at 114.9 mc and modulate it at 30 percent with the VOR signal from Modulator MD-83A/ARN. Connect output of Signal Generator SG-1/ARN to input of the navigation receiver.

b. Set the PHASE ANGLE SELECTOR on Modulator MD-83A/ARN to 90°. Center the microammeter by setting the COURSE on ID-249A/ARN to approximately 90° with the SET control. Do not change this SET control setting.

c. Substitute Signal Generator SG-13/ARN for Signal Generator SG-1/ARN and Modulator MD-83A/ARN. Set MEGACYCLES dial to 114.9 mc and adjust CARRIER SET control for red line indication. Turn VOR switch to 90°.

d. Adjust VOR TRACK control (figure 6-11) for exact centering of the microammeter. The TO-FROM indication will be TO.

e. Recheck the VOR ZERO adjustment as outlined in paragraph 6-53 with the PHASE ANGLE SELECTOR on Modulator MD-83A/ARN set to 180° and note the error between 0° and 180°. If this error exceeds 0.75° readjust VOR ZERO control to add or subtract half the error from 0°.

f. Recheck the VOR TRACK adjustment given in steps a through d above with the PHASE ANGLE SELECTOR on Modulator MD-83A/ARN set to 270° and note the error between 90° and 270°. If this error exceeds 0.75° readjust VOR TRACK control to add or subtract half the error from 90°. After both the VOR ZERO and VOR TRACK adjustments are made, lock both controls.

6-55. PHASE LOCALIZER ADJUSTMENT. PHASE LOC CENTER and LEVEL controls (figure 6-11) are used to align the phase localizer for the previously determined positions of the localizer sectors and center setting of the control knob. The 30 cps modulation level and 30∿ LEVEL SET control must be adjusted prior to the ϕ LOC CENTER and LEVEL control adjustments.

a. Connect the Ballantine electronic voltmeter to the AUDIO OUT connector of Signal Generator SG-13/ARN. Set MEGACYCLES control to 110.1 mc, adjust SET LINE TO 21V, METER ZERO, and CARRIER SET controls.

b. Turn AUDIO SELECTOR to the 30∿ VAR ϕ position and note the 30 cps voltage obtained at the AUDIO OUT connector. It should be approximately 0.65 volts.

c. Turn AUDIO SELECTOR to ϕ LOC position and ground the junction of C1424 and C1425 to render the 9960 FM oscillator inoperative. See figure 6-11.

d. Turn the LOC-GS control to the right and set the knob center line on the top engraved line of the right hand sector.

e. Set the ϕ LOC LEVEL control to obtain a voltage reading on the Ballantine voltmeter which is 38 percent of the voltage noted above in the 30∿ VAR ϕ position. With the 9960 FM oscillator still inoperative set the LOC-GS control to the middle of the white center sector engraved on the panel and adjust the ϕ LOC CENTER control for a null reading of the meter. Recheck the ϕ LOC LEVEL control and readjust if necessary. Turning the LOC-GS control to the top engraved line of left sector, a voltage reading will be obtained which is the same as the top line of the right hand sector if the two sectors have been very carefully adjusted as instructed in paragraph 6-50. Lock the controls.

6-56. LUBRICATION.

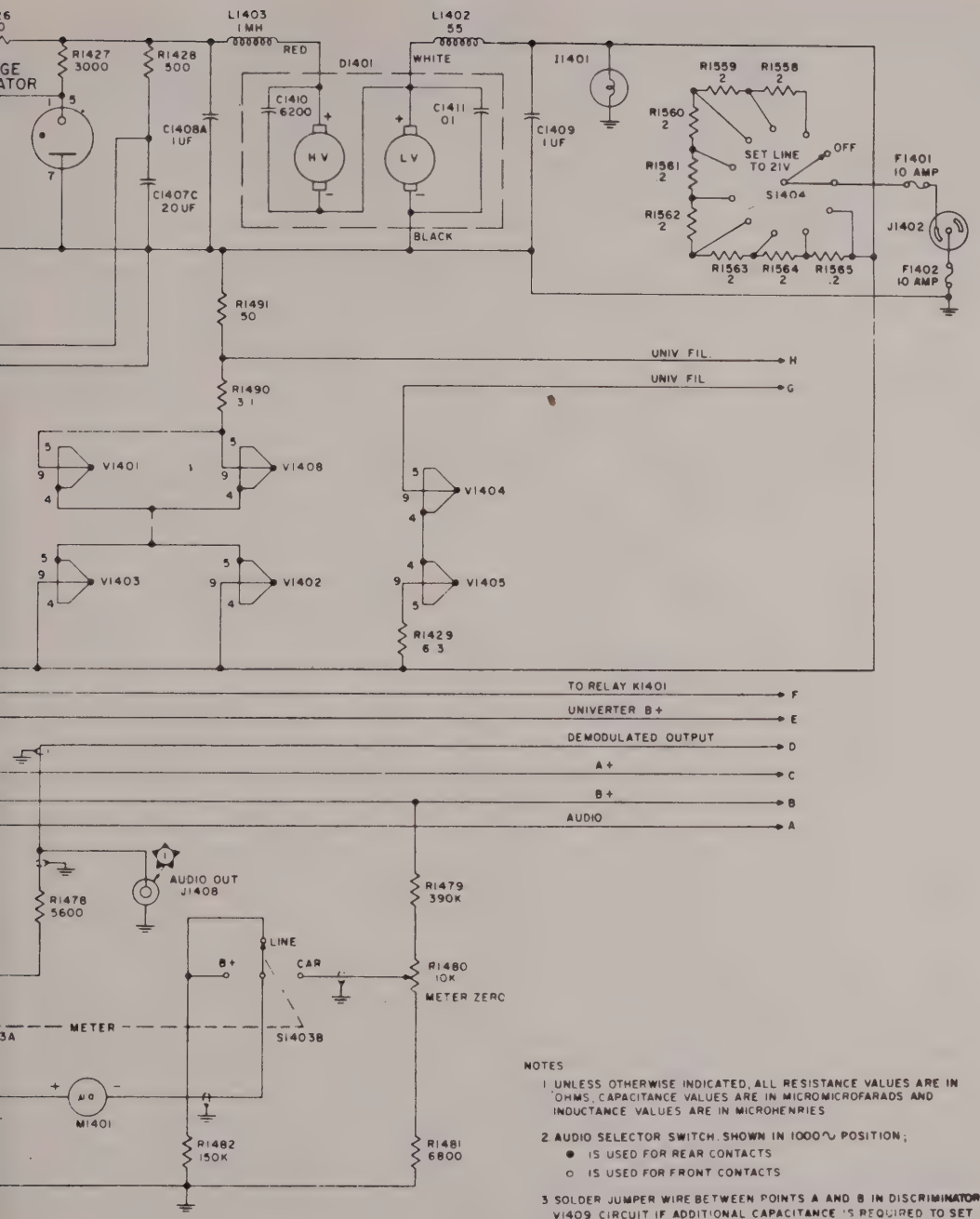
6-57. The signal generator must be lubricated at least every 500 hours as given in Section V, paragraph 5-17.

6-58. INSPECTION SCHEDULE.

6-59. The signal generator should be inspected periodically to prolong service life and assure continued operation of the equipment. Refer to Section V, paragraphs 5-19 through 5-22 for inspection schedule.

SECTION VII

DIAGRAMS



NOTES

1. UNLESS OTHERWISE INDICATED, ALL RESISTANCE VALUES ARE IN OHMS, CAPACITANCE VALUES ARE IN MICROMICROFARADS AND INDUCTANCE VALUES ARE IN MICROHENRIES
2. AUDIO SELECTOR SWITCH SHOWN IN 1000~ POSITION;
   - ● IS USED FOR REAR CONTACTS
   - ○ IS USED FOR FRONT CONTACTS
3. SOLDER JUMPER WIRE BETWEEN POINTS A AND B IN DISCRIMINATOR V1409 CIRCUIT IF ADDITIONAL CAPACITANCE IS REQUIRED TO SET 9960 FM FREQ

SECTION VII

DIAGRAMS

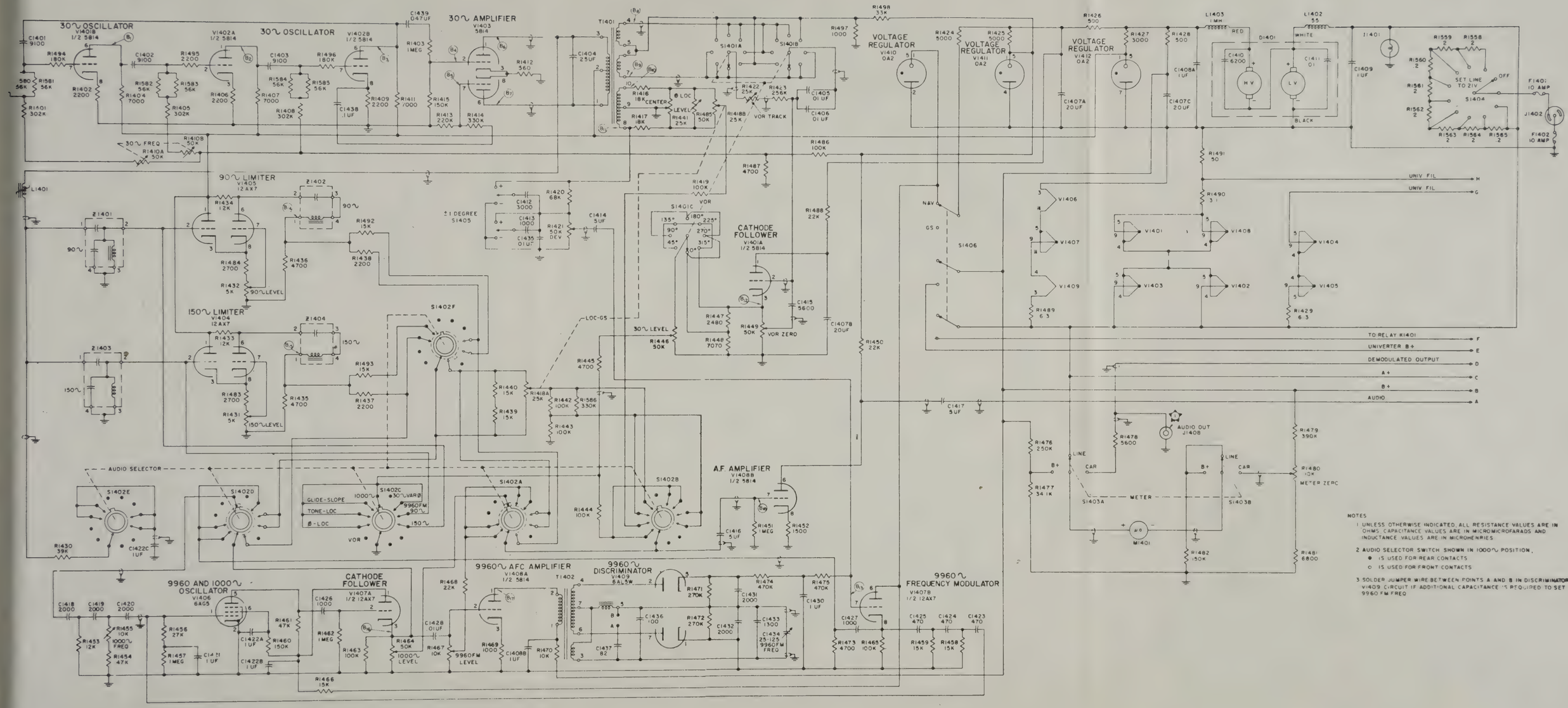
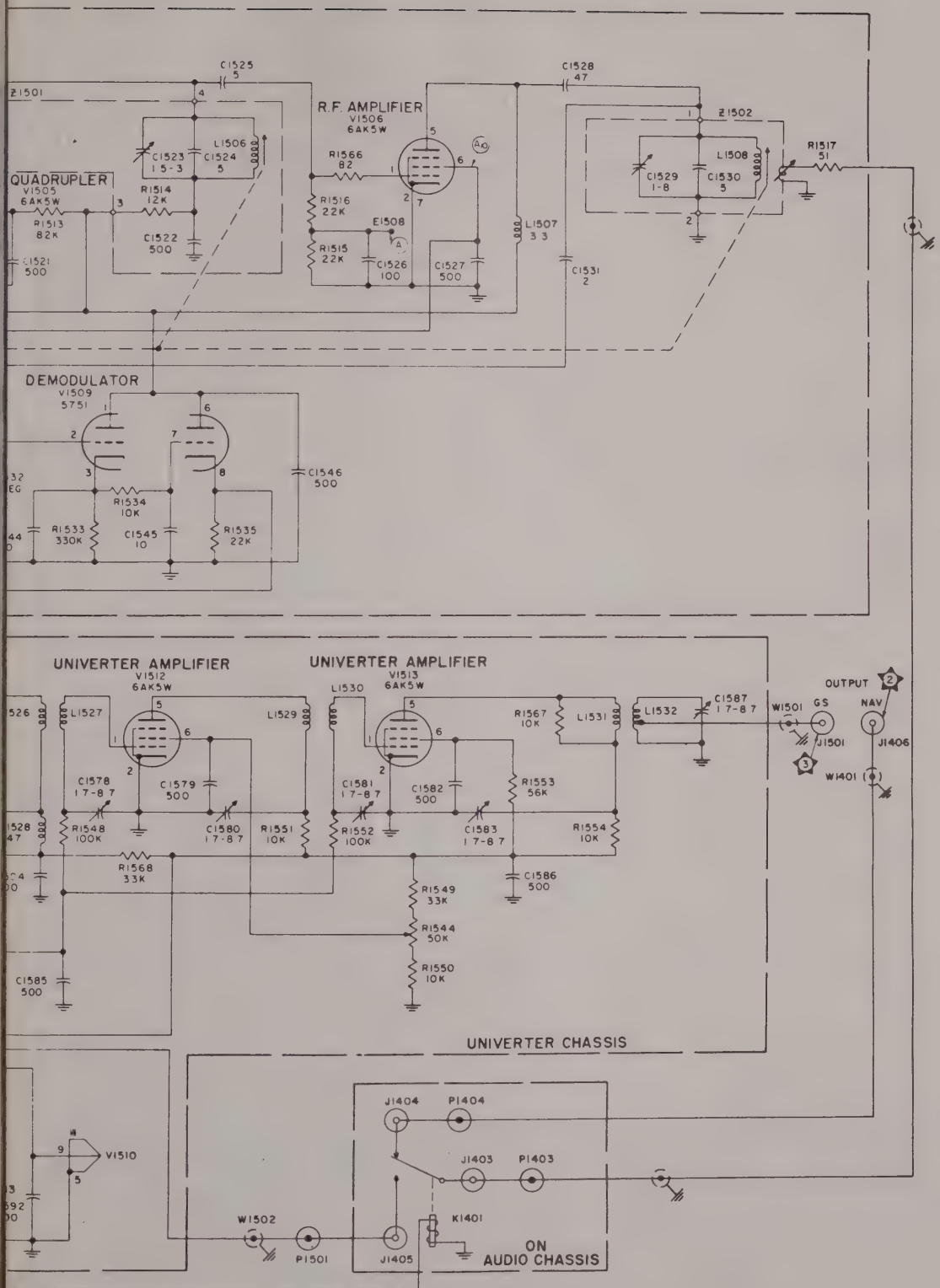
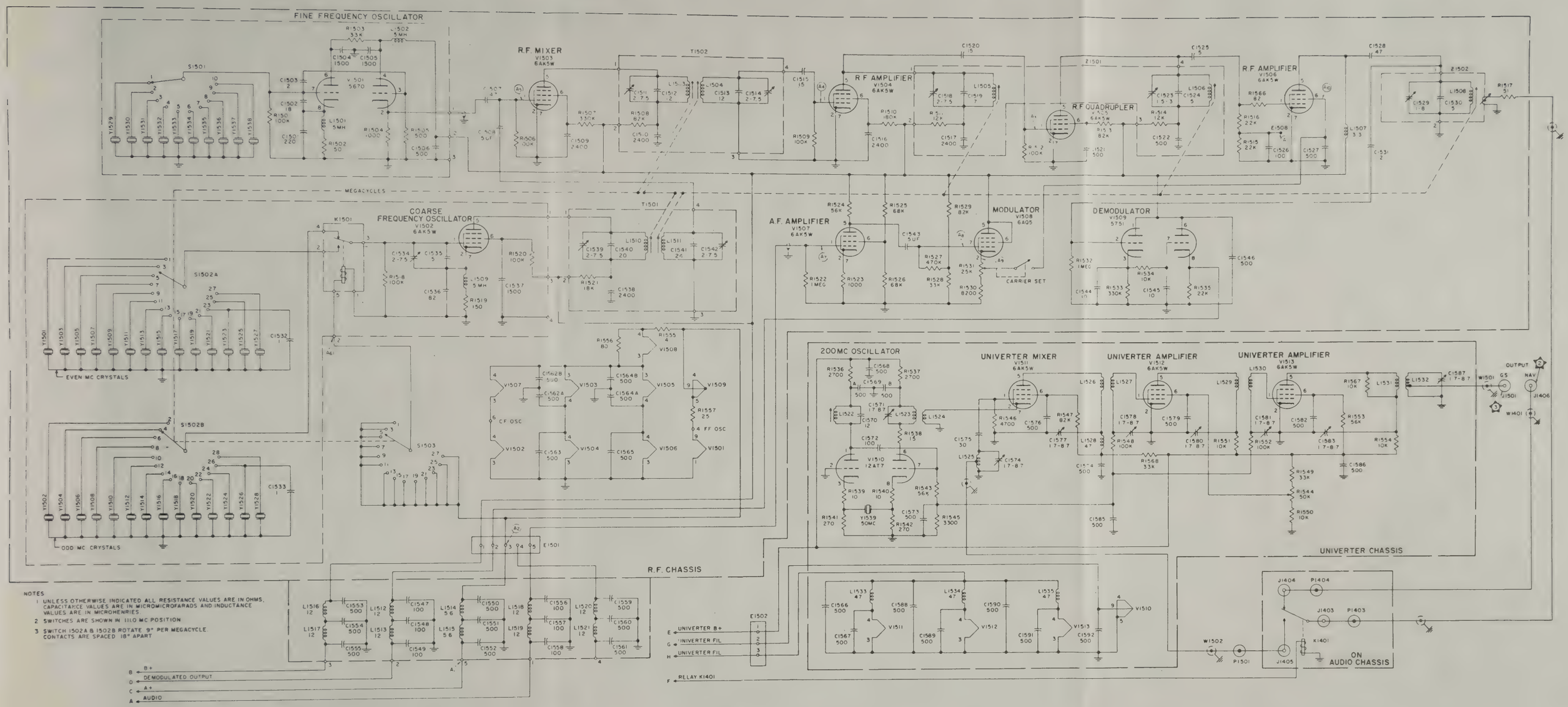


Figure 7-1. Signal Generator SG-13/ARN, Audio Chassis, Schematic Diagram

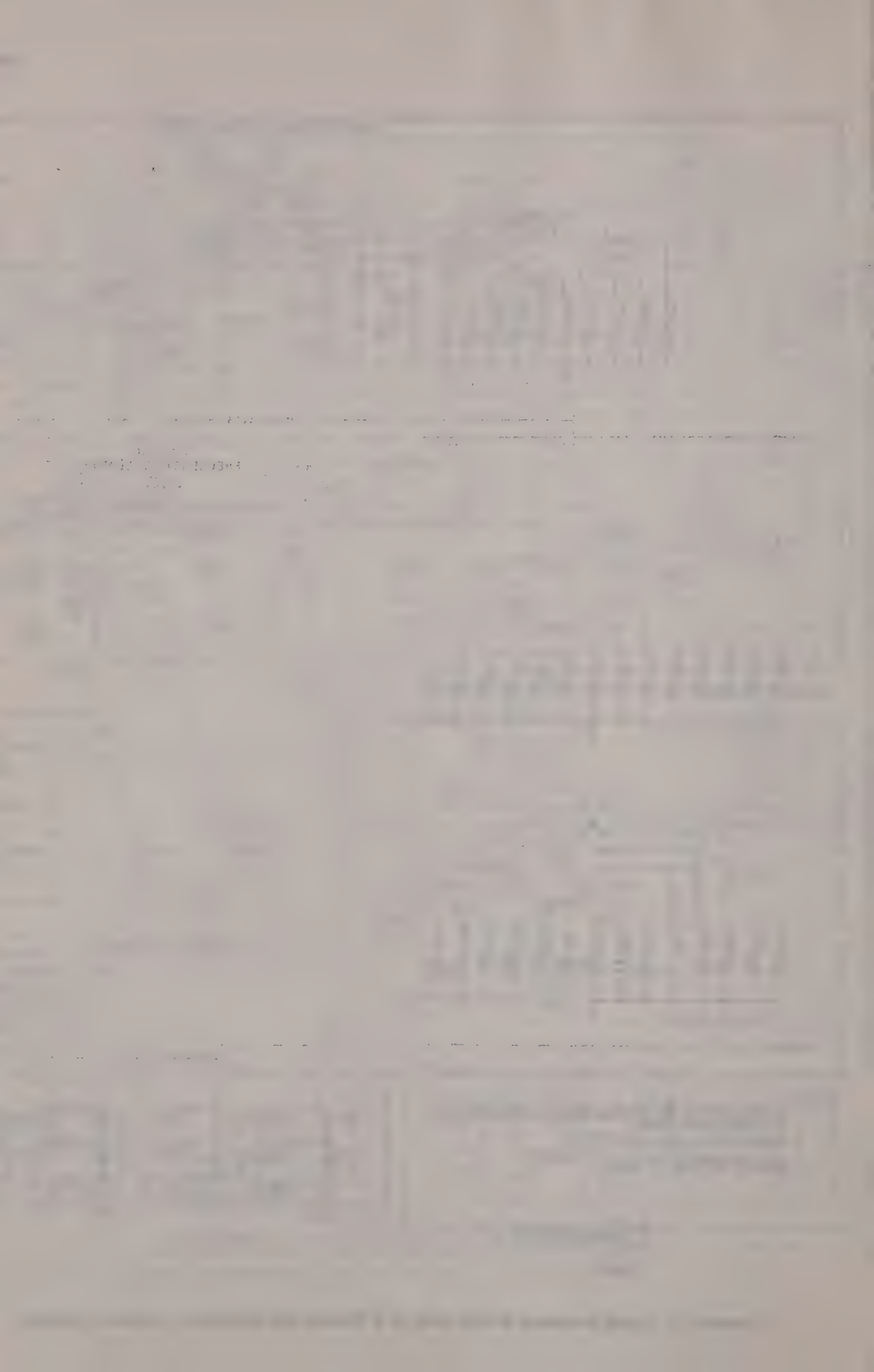

Z1501
C1525 5
C1528 47
Z1502
R.F. AMPLIFIER
V1506 6AK5W
C1523 1.5-3
L1506
C1524 5
QUADRUPLER
V1505 6AK5W
R1513 82K
R1514 12K
C1521 500
C1522 500
R1566 82
R1516 22K
R1515 22K
E1508
C1526 100
C1527 500
L1507 3.3
C1531 2
C1529 1-8
L1508
C1530 5
R1517 51
DEMODULATOR
V1509 5751
C1546 500
R1534 10K
R1533 330K
C1545 10
R1535 22K
UNIVERTER AMPLIFIER
V1512 6AK5W
L1527
L1529
C1578 1.7-8.7
C1579 500
R1548 100K
C1580 1.7-8.7
R1551 10K
R1568 33K
UNIVERTER AMPLIFIER
V1513 6AK5W
L1530
R1567 10K
L1531
L1532
C1587 1.7-8.7
C1581 1.7-8.7
C1582 500
R1553 56K
R1552 100K
C1583 1.7-8.7
R1554 10K
C1586 500
R1549 33K
R1544 50K
R1550 10K
C1585 500
W1501
GS
NAV
OUTPUT
J1501
J1406
W1401
UNIVERTER CHASSIS
V1510
J1404
P1404
J1403
P1403
W1502
P1501
J1405
K1401
ON AUDIO CHASSIS

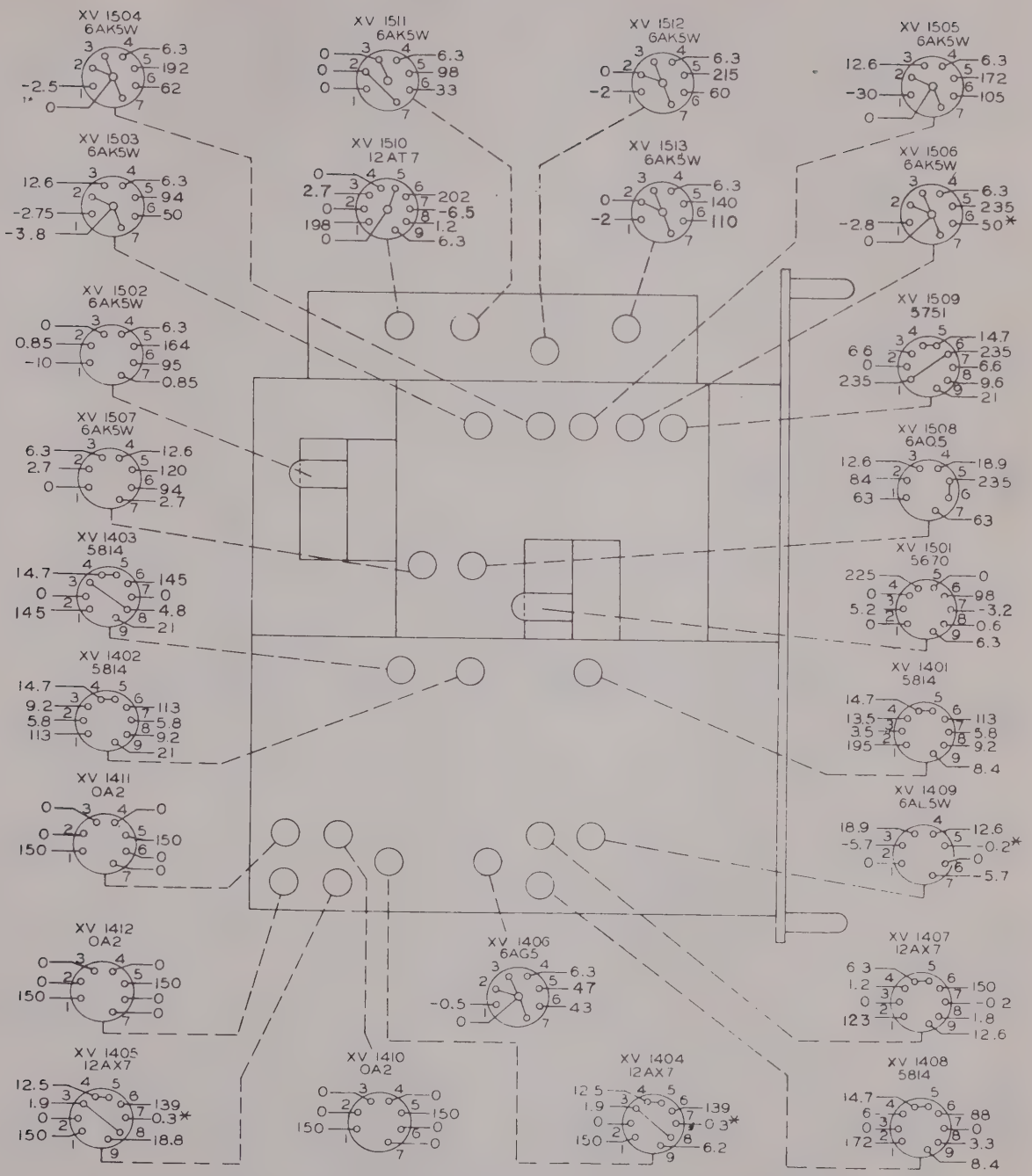


NOTES

1. UNLESS OTHERWISE INDICATED ALL RESISTANCE VALUES ARE IN OHMS, CAPACITANCE VALUES ARE IN MICROMICROFARADS AND INDUCTANCE VALUES ARE IN MICROHENRIES.
2. SWITCHES ARE SHOWN IN 111.0 MC POSITION
3. SWITCH 1502A & 1502B ROTATE 9° PER MEGACYCLE. CONTACTS ARE SPACED 18° APART

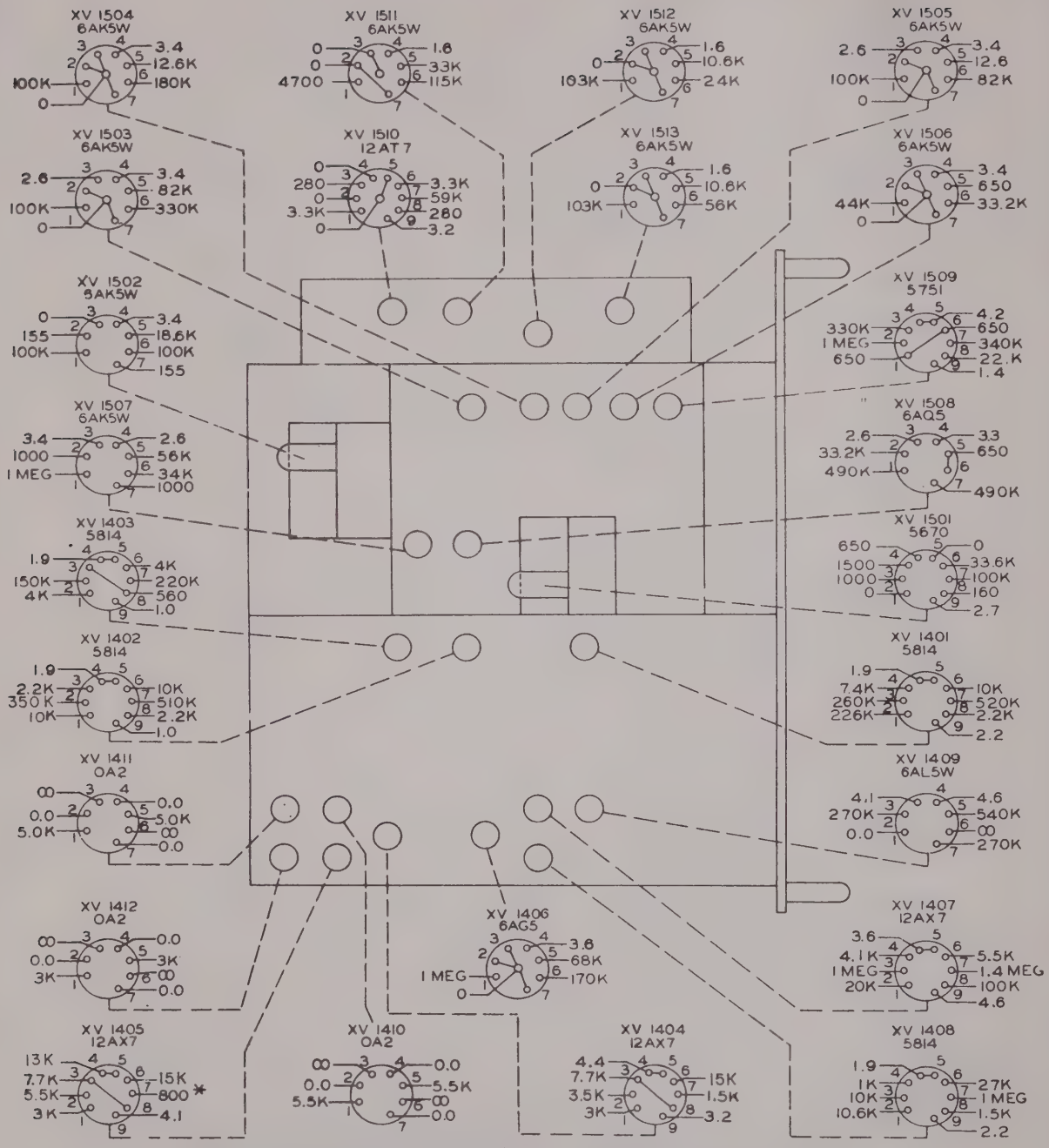
Figure 7-2. Signal Generator SG-13/ARN, R-F Chassis and Univerter, Schematic Diagram





NOTES: VOLTAGE POSITIVE UNLESS OTHERWISE INDICATED
MEASUREMENTS MADE WITH ELECTRONIC DESIGNS MODEL 100, VTVM.
LINE VOLTAGE SET TO 21V; VOR SWITCH ON 0°; LDC-GS CONTROL SET TO CENTER POSITION; METER SWITCH ON CAR POSITION; SET CARRIER ADJUSTED TO THE RED LINE. FOR MEASUREMENTS ON V 1401 THROUGH V 1509: NAV-GS SWITCH SET ON NAV; MEGACYCLES CONTROL SET ON 114.9; AUDIO SELECTOR ON VOR. FOR MEASUREMENTS ON V 1510 THROUGH V 1513: NAV-GS SWITCH SET ON GS; MEGACYCLES CONTROL SET ON 332.0 AUDIO SELECTOR ON GLIDE SLOPE

Figure 7-3. Signal Generator SG-13/ARN, D-C Voltage Measurements



NOTES: ALL READING WITH RESPECT TO GROUND.
MEASUREMENTS MADE WITH ELECTRONIC DESIGNS MODEL 100, VTVM. LINE SWITCH TO OFF POSITION; VOR SWITCH ON 0°; LOC-GS CONTROL SET TO CENTER POSITION; METER SWITCH ON LINE POSITION; SET CARRIER TURNED TO MAXIMUM CLOCKWISE POSITION.
FOR MEASUREMENTS ON V 1401 THROUGH V 1509: NAV-GS SWITCH ON NAV; MEGACYCLES CONTROL SET ON 114.9; AUDIO SELECTOR ON VOR. FOR MEASUREMENTS ON V 1510 THROUGH V 1513: NAV-GS SWITCH ON GS; MEGACYCLES CONTROL SET ON 332.0; AUDIO SELECTOR ON GLIDE SLOPE.

Figure 7-4. Signal Generator SG-13/ARN, Resistance Measurements

PART TWO

OPERATION, SERVICE, AND OVERHAUL INSTRUCTIONS

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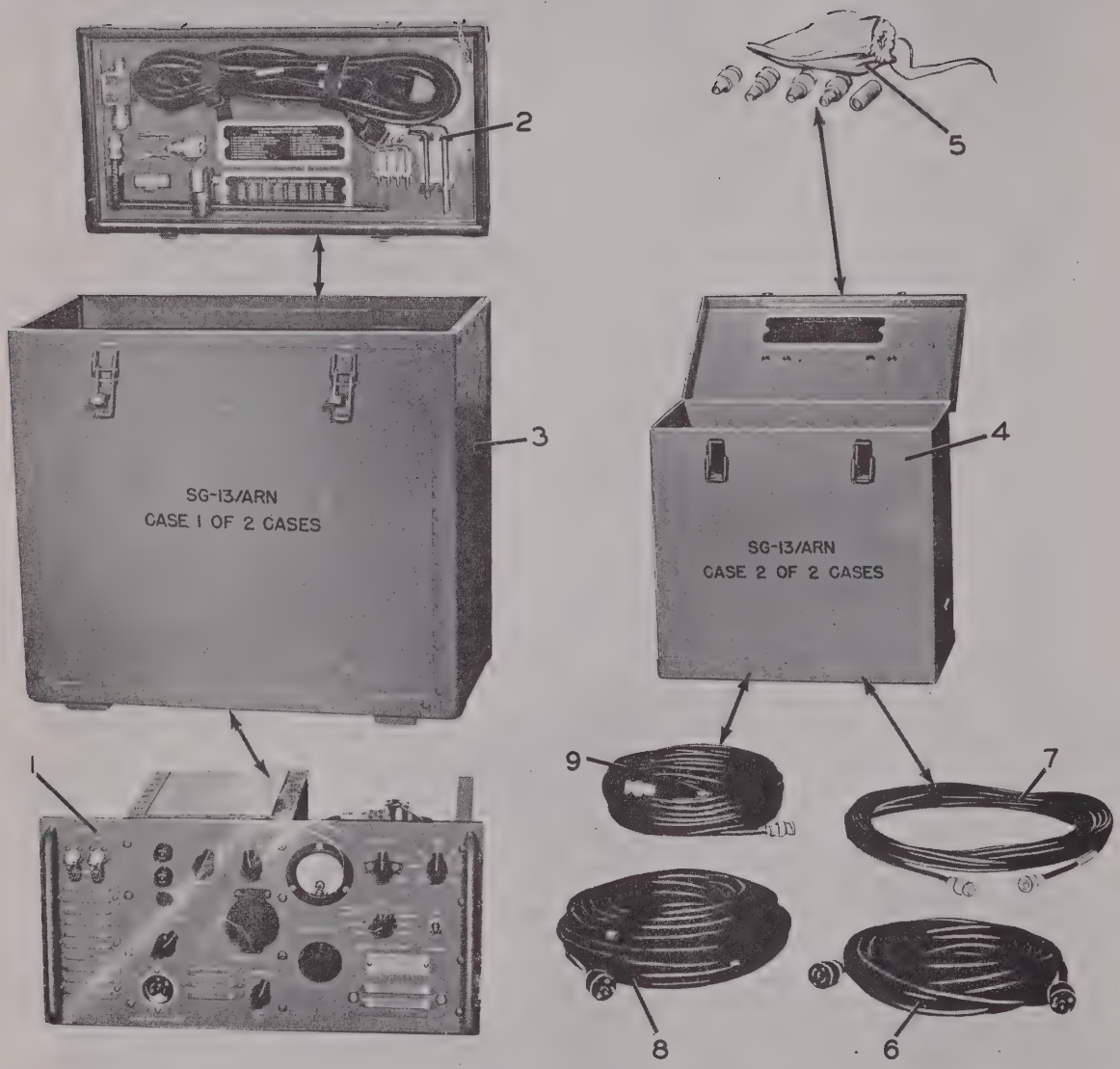


Index No.		Index No.	
1	Test Instrument Proper	6	Power Cord, CX-1506/U (25 ft lg)
2	Case Lid and Accessories (See Figure 1-2)	7	R-F Cord CG-409A/U (25 ft lg)
3	Test Instrument Case	8	Power Cord CX-1506/U (50 ft lg)
4	Accessory Case CY-868/U	9	R-F Cord CG-409A/U (50 ft lg)
5	Accessory Adapters	*10	Power Cord CX-2489/U (1 ft lg)

*Item 10 not shown, supplied on Contracts AF33(038)14566 and AF33(038)27683

Figure 1-1. Signal Generator SG-13/ARN, Equipment Supplied

SECTION I

GENERAL DESCRIPTION

1-1. INTRODUCTION.

1-2. This handbook covers the description, operation procedures, theory of operation, maintenance, overhaul and adjustment of Signal Generator SG-13/ARN. See figure 1-1 for complete equipment. Signal Generator SG-13/ARN is a portable test instrument designed for ramp testing of aircraft navigation and localizer receivers operating in the 108.0 to 135.9 megacycle band and glide slope receivers operating in the 329.3 to 335.0 megacycle band.

1-3. EQUIPMENT SUPPLIED.

CASE 1

QUANTITY	NAME	GOVERNMENT TYPE DESIGNATION
1	Test Instrument Proper	SG-13/ARN
1	Antenna	AT-170/ARN
1	Power Cord (10 ft)	CX-1095U
1	R-F Cord (10 ft)	CG-409A/U
1	Adapter	UG-201/U
1	Adapter	UG-29/U
1	Adapter (impedance matching)	UG-529/U
2	Fuses (10 a, 25 v)	3AG
1	Bristol Wrench #10	
1	Bristol Wrench #8	
1	Bristol Wrench #6	
1	Bristol Wrench #4	
1	Phillips Screwdriver #2	
1	Phillips Screwdriver #1	

CASE 2

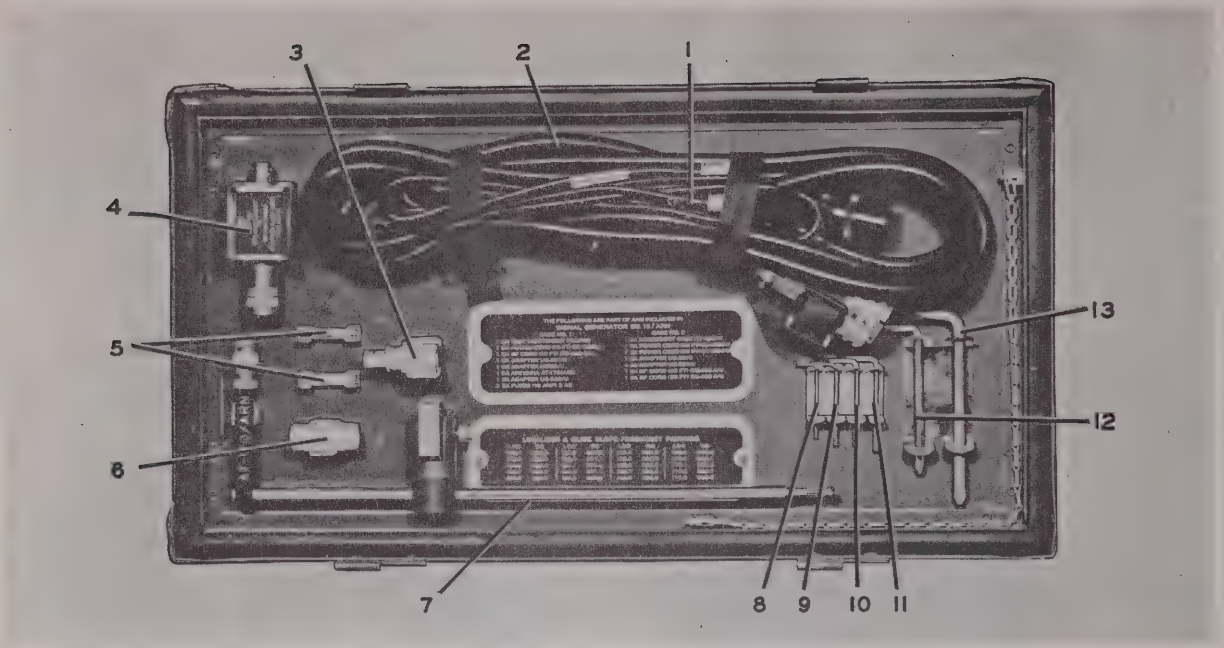
1	Accessory Case	CY-868/U
1	Power Cord (25 ft)	CX-1506/U
1	Power Cord (50 ft)	CX-1506/U
1	R-F Cord (25 ft)	CG-409A/U
1	R-F Cord (50 ft)	CG-409A/U
1	Adapter	UG-29/U
4	Adapter	UG-201/U
1	Power Cord (1 ft)	CX-2489/U

1-4. EQUIPMENT REQUIRED BUT NOT SUPPLIED.

QUANTITY	NAME	GOVERNMENT TYPE DESIGNATION
1	Source of 21-29 volts dc	

1-5. MECHANICAL DESCRIPTION. Signal Generator SG-13/ARN consists of two cases, one of which contains the test instrument and all equipment necessary for operation within 10 feet of the receiver and 10 feet of the power source. The other case known as Accessory Case CY-868/U contains 25 and 50 foot r-f and power cables and additional adapters. The test instrument is mounted and operated in a combination case having a waterproof snap-on cover. The test instrument is divided into two parts, the audio section and the r-f section, each having a separate chassis but with a common front panel. The r-f section is completely shielded, but the top, bottom, and rear covers can be removed for access to the r-f chassis. A univerter mounts on the side of the r-f shield, and can be serviced easily by removing its cover.

1-6. ELECTRICAL DESCRIPTION. Signal Generator SG-13/ARN may be tuned to any one of 280 channels spaced at 100 kc intervals in the range 108.0 to 135.9 megacycles. A univerter provides output signals spaced at 100 kc intervals in the range 329.3 to 335.0 megacycles for glide slope testing. A piston type attenuator enables the r-f output to be varied from 4 to 200,000 microvolts. The r-f signal is obtained by mixing and multiplying the outputs of two crystal controlled oscillators. An audio selector switch is used to select the type of modulating signal desired.



1. R-F Cord (10 ft) CG-409A/U
2. Power Cord (10 ft) CX-1095/U
3. Adapter UG-201/U
4. Impedance matching Adapter UG-529/U
5. Fuse 10a, 25v Type 3AG
6. Adapter UG-29/U
7. Antenna AT-170/ARN
8. #4 Bristol Wrench
9. #6 Bristol Wrench
10. #8 Bristol Wrench
11. #10 Bristol Wrench
12. #1 Phillips Screwdriver
13. #2 Phillips Screwdriver

Figure 1-2. Signal Generator SG-13/ARN, Carrying Case Lid, Showing Accessories

The 30 cps variable phase signal is generated by a 30 cps RC oscillator. The phase of this signal may be varied in 45 degree steps by an RC phase switching network. The same oscillator also supplies a 30 cps reference voltage of constant phase to frequency modulate a 9960 cps RC oscillator. A plus or minus one degree phase switching network shifts the phase of the 30 cps reference voltage for testing omni-range instrumentation sensitivity. The 90 and 150 cps signals for tone localizer and glide slope testing are generated by distorting the output of the 30 cps oscillator and filtering out 3rd and 5th harmonics.

1-7. LEADING PARTICULARS.

1-8. FREQUENCY RANGE. 108.0 to 135.9 mc and 329.3 to 335.0 mc in 100 kc steps.

1-9. NUMBER OF CHANNELS.
108 to 135.9 mc -- 280 channels
329.3 to 335.0 mc -- 58 channels

1-10. OUTPUT RANGE. 4 to 200,000 microvolts.

1-11. OUTPUT SIGNALS
a. Omni-Range (VOR)
b. Tone Localizer
c. Phase Localizer *
d. Glide Slope
e. 1000 cps sine wave
f. 30 cps variable phase sine wave
g. 9960 cps frequency modulated at 30 cps
h. 90 cps sine wave
i. 150 cps sine wave
* This facility is no longer used in military aircraft equipment.

1-12. FREQUENCY STABILITY: R-f output ±0.0065%

1-13. INPUT VOLTAGE.
Nominal: 21. volts dc
Range: 21 to 29 volts dc

1-14. CURRENT REQUIREMENTS. 5.4 amperes.

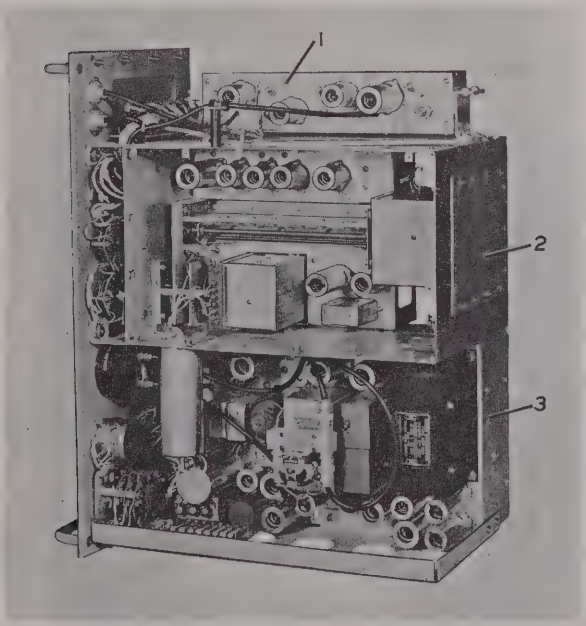
1-15. FUSE COMPLEMENT. One 10-ampere fuse in each side of line.

1-16. COMPONENT WEIGHTS.
Signal Generator SG-13/ARN (Case 1) -- 45 lbs.
Accessory Case CY-868/U (Case 2) -- 15 lbs.

1-17. DYNAMOTOR DATA.
Manufacturer's Type No: Continental Elec. DMF 306
Collins Part No: 231 0043 00
Input Voltage: 21 V DC
Input Current 3.3 amperes
Output Voltage: 260 V DC
Output Current: 0.135 amperes
Temperature Rise: Not to exceed 40°C (106°F.) above 55°C. (131°F.).

1-18. TUBE COMPLEMENT BY FUNCTION.

SYMBOL NUMBER	JAN TYPE	FUNCTION
V1401A	1/2 5814	30 cps variable phase amplifier
V1401B	1/2 5814	30 cps oscillator
V1402A, B	5814	30 cps oscillator
V1403A, B	5814	30 cps amplifier
V1404A, B	12AX7	150 cps limiter
V1405A, B	12AX7	90 cps limiter
V1406	6AG5	9960 and 1000 cps oscillator
V1407A	1/2 12AX7	9960 and 1000 cps amplifier
V1407B	1/2 12AX7	9960 cps frequency modulator
V1408A	1/2 5814	9960 cps AFC amplifier
V1408B	1/2 5814	A-f amplifier
V1409A, B	6AL5W	9960 cps discriminator
V1410	OA2	Voltage regulator
V1411	OA2	Voltage regulator
V1412	OA2	Voltage regulator
V1501	5670	Fine frequency oscillator
V1502	6AK5W	Coarse frequency oscillator-tripler
V1503	6AK5W	R-f mixer
V1504	6AK5W	R-f amplifier
V1505	6AK5W	R-f quadrupler
V1506	6AK5W	Final r-f amplifier
V1507	6AK5W	A-f amplifier
V1508	6AQ5	Modulator
V1509A, B	5751	Demodulator
V1510	12AT7	200-mc oscillator
V1511	6AK5W	Univerter mixer
V1512	6AK5W	Univerter amplifier
V1513	6AK5W	Univerter amplifier



1. Univerter Chassis
2. R-F Chassis
3. Audio Chassis

Figure 1-3. Signal Generator SG-13/ARN, Chassis Layout

1-19. TUBE COMPLEMENT BY QUANTITY:

Type	Quantity
5670	1
6AK5W	9
6AQ5	1
12AX7	3
12AT7	1
6AG5	1
6AL5W	1
5814	4
OA2	3
5751	1

SECTION II

OPERATION PROCEDURES

2-1. OPERATING CONTROLS.

2-2. USES. The purpose of each operating control on the front panel of Signal Generator SG-13/ARN is as follows. See figure 2-1 for location of each control.

a. SET LINE TO 21V. This switch is the power on-off switch as well as a nine position step rheostat for adjusting the d-c input voltage. It is adjusted for a meter reading of 21 volts when the METER switch is in the LINE position.

b. CARRIER SET. This control is used to adjust the r-f carrier output to the red line on the meter, with the meter in CAR position The adjustment is made for each frequency chosen by the MEGACYCLES control.

c. METER ZERO. The METER ZERO adjustment is located behind the front access door. This control is adjusted for zero reading on the meter with the CARRIER SET control turned off (maximum counter-clockwise position), and the METER switch in the CAR position.

d. METER. This is a three position switch for switching the meter for various functions. In the B+ position the unregulated B+ voltage is indicated on the meter. In the LINE position the input voltage to the dynamotor and filament circuits is indicated on the meter. The CAR position in addition to its use in adjusting METER ZERO, is used when adjusting the r-f carrier output to the red line on the meter with the CARRIER SET control.

e. MICROVOLTS. The microvolts dial is used to adjust the r-f attenuator to the desired output. Its calibration is not correct until the CARRIER SET control is adjusted for a red line indication on the meter. It is calibrated from 4 to 200,000 microvolts. The unmarked lines on the dial represent even numbers. For instance, the four unmarked lines between 1K and 10K represent 2K, 4K, 6K and 8K microvolts respectively. The significance of these settings is discussed in Section III, paragraph 3-19.

f. MEGACYCLES. This is a frequency selector consisting of two concentric knobs, the outer knob for selecting megacycle steps and the inner knob for tenth-megacycle steps. The frequency selected appears in a vertical window the numbers of which represent, top to bottom, hundreds, tens, units, and tenths of megacycles.

g. NAV-GS. The NAV-GS switch is used for selecting 108.0 to 135.9-mc signals or 329.3 to 335.0-mc signals. It switches B+ leads and operates the coaxial relay which connects r-f output to the univerter for 329.3 to 335.0-mc operation. It also changes the top number in the vertical window from 1 to 3 in changing from 100 to 300-mc operation.

h. AUDIO SELECTOR. The AUDIO SELECTOR control is used to select the type of audio signal to modulate the r-f carrier.

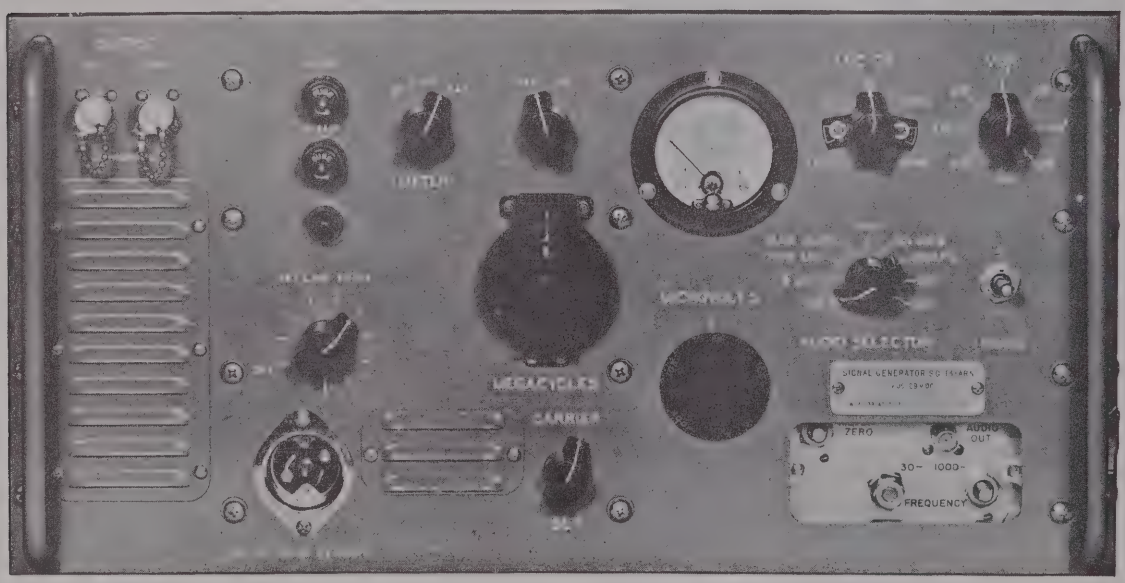


Figure 2-1. Signal Generator SG-13/ARN, Front Panel Controls

i. VOR. The VOR control enables the operator to shift the 30 cps variable phase component of the VOR signal in 45° steps around the azimuth. Eight omni-bearings from 0 through 315° are available for checking omni-range receivers.

j. ±1 DEGREE. The ±1 DEGREE switch is used to shift the omni-bearing indicated on the VOR switch one degree in either direction. Sensitivity of omni-range receivers to small changes in omni-bearing may be checked with this control.

k. LOC-GS. The LOC-GS control is a potentiometer used to vary the ratio of the 90 and 150 cps signals on the TONE LOC and GLIDE SLOPE positions of the AUDIO SELECTOR switch. On the ∅ LOC position of the AUDIO SELECTOR switch, it is used to vary the percentage modulation of the 30 cps reversible phase signal. Localizer and Glide Slope instrumentation sensitivity is checked by the use of the LOC-GS control.

l. 30 ∼ FREQUENCY. The 30 cps oscillator is adjusted to exactly 30 cps with this control.

m. 1000 ∼ FREQUENCY. The 1000 cps oscillator is adjusted to 1000 cps or any other frequency within its limited range with this control.

n. AUDIO OUT. The AUDIO OUT connector provides a demodulated output for test purposes.

o. OUTPUT, NAV-GS. The output for omni-range and localizer signals (108.0 to 135.9 mc) is obtained at the NAV output connector. Glide slope output (329.3 to 335.0 mc) is obtained at the GS output connector. Both terminals connect to R-F cord CG-409A/U.

2-3. ADJUSTMENTS.

2-4. The procedure below outlines the adjustments to be made prior to operation of the instrument.

a. Turn SET LINE TO 21V control to OFF position.

CAUTION

To avoid damaging the equipment, be certain that the SET LINE TO 21V control is placed in the OFF position before connecting the source of power. Then, as the control is turned on, full dropping resistance is placed in series with the input source and the equipment is protected from high input voltage.

b. Connect either Power CORD CX-1095/U or CX-1506/U to the 21VDC - 29VDC connector on Signal Generator SG-13/ARN and to the 21-29 volt source of power.

c. Turn METER switch to LINE position and adjust SET LINE TO 21V switch until the meter reads 21 ±0.5 volts.

d. Turn METER switch to B+ position and read B+ voltage on the meter. Reading should be 230 volts. Allow 3 minutes warm-up.

e. With METER switch in CAR position, and CARRIER SET control fully counterclockwise, adjust METER ZERO control until the meter reads zero. This adjustment is not critical. The meter may be off zero by several divisions with only a small error in r-f attenuator calibration.

f. Set NAV-GS switch to NAV position for 108.0 to 135.9-mc operation or to GS position for 329.3 to 335.0-mc operation.

g. Select frequency on MEGACYCLES selector switch.

h. To set up a specified signal strength, rotate MICROVOLTS dial to desired output level and with the METER switch in the CAR position set meter to red line with CARRIER SET control.

NOTE

The meter must be reset to the red line with the CARRIER SET control each time the frequency is changed.

i. Select desired modulating signal on AUDIO SELECTOR control.

2-5. CONNECTIONS.

2-6. Case I of Signal Generator SG-13/ARN contains all the equipment necessary for operation of the instrument at distances up to 10 feet from the power source and the equipment under test. Accessory Case CY-868/U contains 25 and 50 foot power and r-f cables which permit operation at distances up to 85 feet from the power source and the equipment under test. A total distance of 170 feet between the power source and equipment under test is therefore possible.

2-7. DIRECT CONNECTION TO RECEIVER. Testing of receivers exclusive of the antenna system is accomplished by making a direct connection from Signal Generator SG-13/ARN to the antenna connector of the receiver using R-F CORD CG-409A/U together with Adapter UG-201/U. Any combination of the 10, 25 or 50-foot lengths may be used by connecting them in series using two Adapters UG-201/U connected to one Adapter UG-29/U. See figures 2-5 and 2-6.

2-8. USE OF ANTENNA AT-170/ARN. For overall installation checks including the receiving antenna system, antenna AT-170/ARN is attached to the proper OUTPUT connector of Signal Generator SG-13/ARN and then clamped securely to the edge of the case. See figures 2-2 and 2-3. The antenna must be broadside to the direction in which the signal is to be radiated. It must be connected to the NAV connector and extended to its full length for all signals in the 108.0 to 135.9 mc range. For glide slope operation, 329.3 to 335.0 megacycles, it must be fully retracted and connected to the GS connector of Signal Generator SG-13/ARN. The MICROVOLTS dial should always be set to its maximum or 200 K setting when using AT-170/ARN.

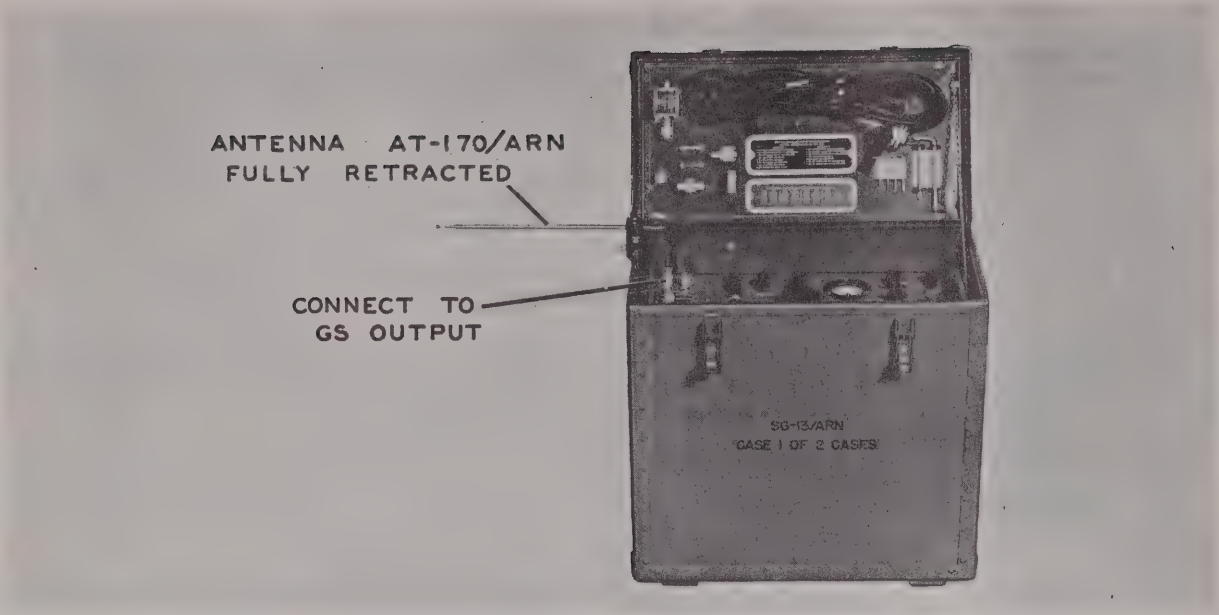


Figure 2-2 Connections for Checking Operation of Glide Slope Receivers and Their Antenna Systems

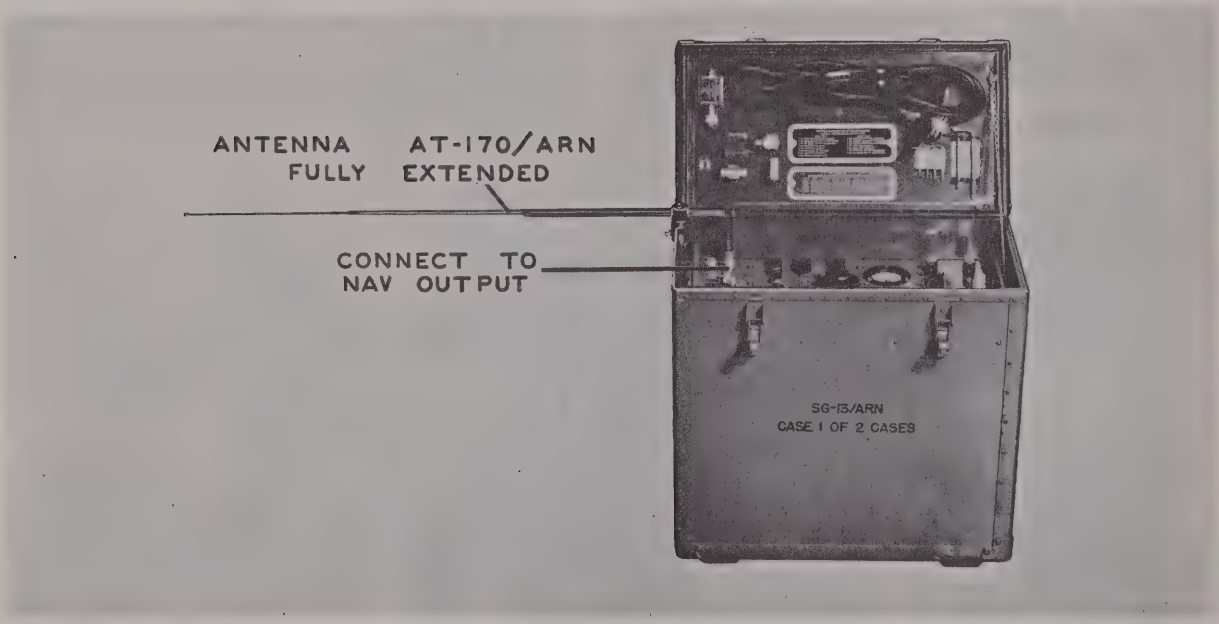


Figure 2-3. Connections for Checking Operation of Navigation Receivers and Their Antenna Systems.

NOTE

Complete receiver testing using Antenna AT-170/ARN is recommended only after communication officers correlate signal strengths obtained outside the aircraft using the antenna with those obtained when Signal Generator SG-13/ARN is directly connected to the receiver. Such correlation must be carried out for each type of aircraft since the receiving antenna location may vary with each type of aircraft. Further, position of Antenna AT-170/ARN with respect to the receiving antenna must be specified and maintained for each type of aircraft. Unless this procedure is carefully adhered to wide discrepancies in flag sensitivities may exist. See figure 2-4 for signal levels observed in a typical situation, where a nearby obstruction causes a dissymmetry in the field strength pattern.

2-9. OPERATING PROCEDURES.

2-10. TESTING OMNI-RANGE RECEIVERS. To check the omni-range operation of navigation receivers follow the procedure below.

a. Carry out adjustments listed under paragraph 2-3.

b. Make connections in accordance with instructions in paragraph 2-7 above.

c. Turn AUDIO SELECTOR to VOR position, and NAV-GS switch to NAV position,

d. Tune Signal Generator SG-13/ARN and receiver to desired frequency in the 112.0 to 117.9 mc band. With the METER switch in CAR position, set meter to red line with CARRIER SET control.

e. Rotate the SG-13/ARN MICROVOLTS dial clockwise until the flag alarm OFF indicator on the receiver's course deviation indicator disappears from the vertical bar. Compare the resulting MICROVOLTS setting with the flag sensitivity value called out in the navigation receiver handbook.

f. Select an omni-bearing on the VOR switch. Use a MICROVOLTS setting of 1000 microvolts. Center the vertical bar of the course deviation indicator with the receiver omni-bearing selector. The COURSE indication should read the same as the setting on the SG-13/ARN VOR switch setting. Consult the receiver handbook for acceptable tolerances. Repeat for the remaining seven radial settings of the VOR switch.

NOTE

The VOR switch setting provides an output signal simulating that received by an aircraft flying to a ground station. Therefore the course indication noted above reads the same as the VOR switch setting only when the TO-FROM indicator reads TO. The vertical bar may be centered with the indicated course reading 180 degrees from the VOR switch setting, in which case the TO-FROM indicator would read FROM.

g. Test the omni-bearing indicator and crosspointer sensitivity to small omni-bearing changes with the +1 DEGREE switch. Consult the receiver handbook for acceptable tolerances. Tap the instruments lightly before reading if the engines are not operating.

h. Rotate the omni-bearing selector knob through 360 degrees and note operation of the TO-FROM indicator.

i. Tune Signal Generator SG-13/ARN and receiver to desired frequency in the 118 to 135.9 mc band. Set meter to red line with CARRIER SET control.

j. Check the receiver's aural output by placing the SG-13/ARN AUDIO SELECTOR switch in the 1000 $\sim$ position and listening for the tone in the receivers headset.

2-11. TESTING LOCALIZER RECEIVERS. To check the localizer operation of navigation receivers follow the procedure outlined below.

a. Carry out adjustments listed under paragraph 2-3, above.

b. Make connections in accordance with instructions in paragraph 2-7 above.

c. Turn AUDIO SELECTOR to TONE LOC and NAV-GS switch to NAV position.

d. Tune Signal Generator SG-13/ARN and receiver to desired channel in 108 to 110.9 mc band. Set meter to red line with CARRIER SET control.

e. Rotate the MICROVOLTS dial on Signal Generator SG-13 clockwise until the flag alarm OFF indicator on the receiver's course deviation indicator disappears from the vertical bar. Consult the receiver handbook for correct flag sensitivity values.

f. Rotate the LOC-GS control over the range covered by the left segment and note the amount of crosspointer deflection to the left. With the LOC-GS control set at the middle of the left segment the vertical bar of Course Indicator ID-249A/ARN should be displaced to the second dot on the left.

NOTE

Tests in paragraphs f. and g. are based on a standard localizer receiver sensitivity of 90 microamperes deflection for a 4 db ratio between tones.

g. Rotate the LOC-GS control over the range covered by the right segment and note the amount of crosspointer deflection to the right. With the LOC-GS control set at the middle of the right segment the vertical bar of Course Indicator ID-249A/ARN should be displaced to the second dot on the right.

h. Check crosspointer centering by turning the LOC-GS control to the white center sector. The crosspointer should be centered when the LOC-GS control is within this sector.

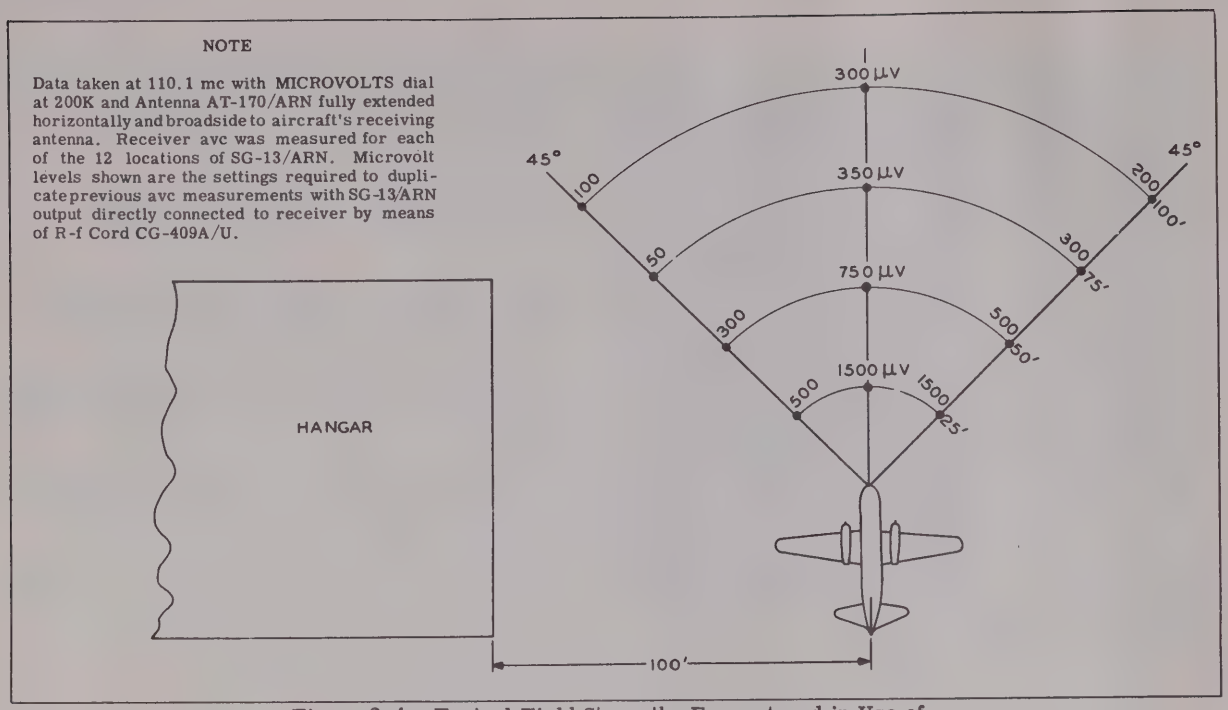


Figure 2-4. Typical Field Strengths Encountered in Use of Signal Generator SG-13/ARN with Nearby Obstruction

i. The phase localizer function of the receiver is tested in the same manner as tone localizer except that ∅ LOC is selected on the AUDIO SELECTOR and the receiver control box.

2-12. TESTING GLIDE SLOPE RECEIVERS. To check the operation of glide slope receivers follow the procedure outlined below.

a. Carry out adjustments listed under paragraph 2-3, above.

b. Make connections in accordance with instructions in paragraph 2-5, above.

c. Turn AUDIO SELECTOR to GLIDE SLOPE position and NAV-GS switch to GS position.

d. Tune Signal Generator SG-13/ARN and glide slope receiver to desired channel in 329.3 to 335.0 megacycle band. Set meter to red line with CARRIER SET control.

e. Rotate the LOC-GS control over the range covered by the left segment and note the upward deflection of the crosspointer. At the middle of the segment the deflection should be 2 dots on Course Indicator ID-249A/ARN. Repeat this procedure for a downward deflection with the other segment.

NOTE

Test of paragraph e. is based on a standard glide slope receiver sensitivity of 90 microamperes for a 2 db ratio between tones.

f. Check the crosspointer centering by turning the LOC-GS control to the small center segment. The crosspointer should be centered when the LOC-GS control is within this sector.

Figure 2-5. Connections for Extending R-F Cord CG-409A/U.

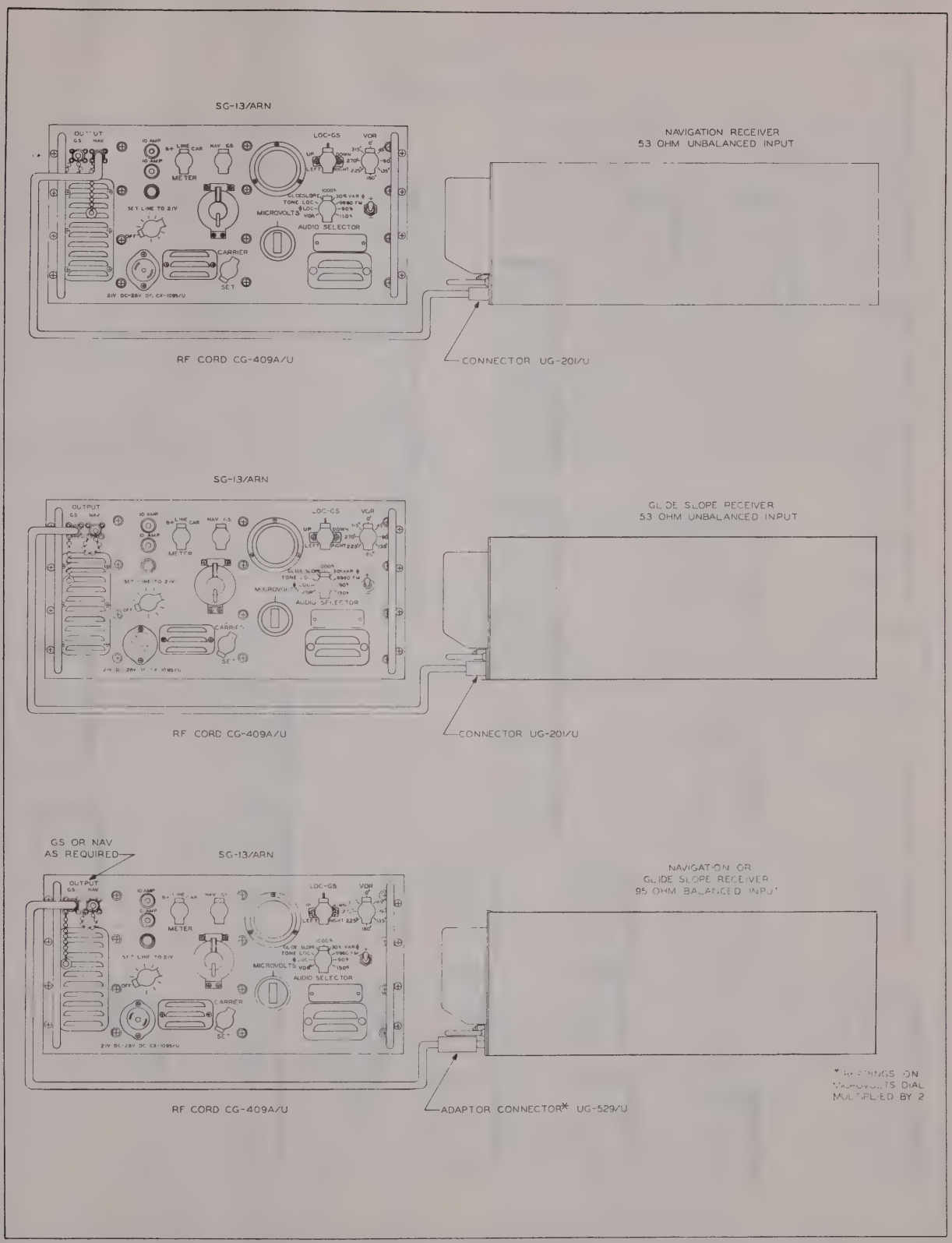


Figure 2-6. Direct Receiver Test Connections

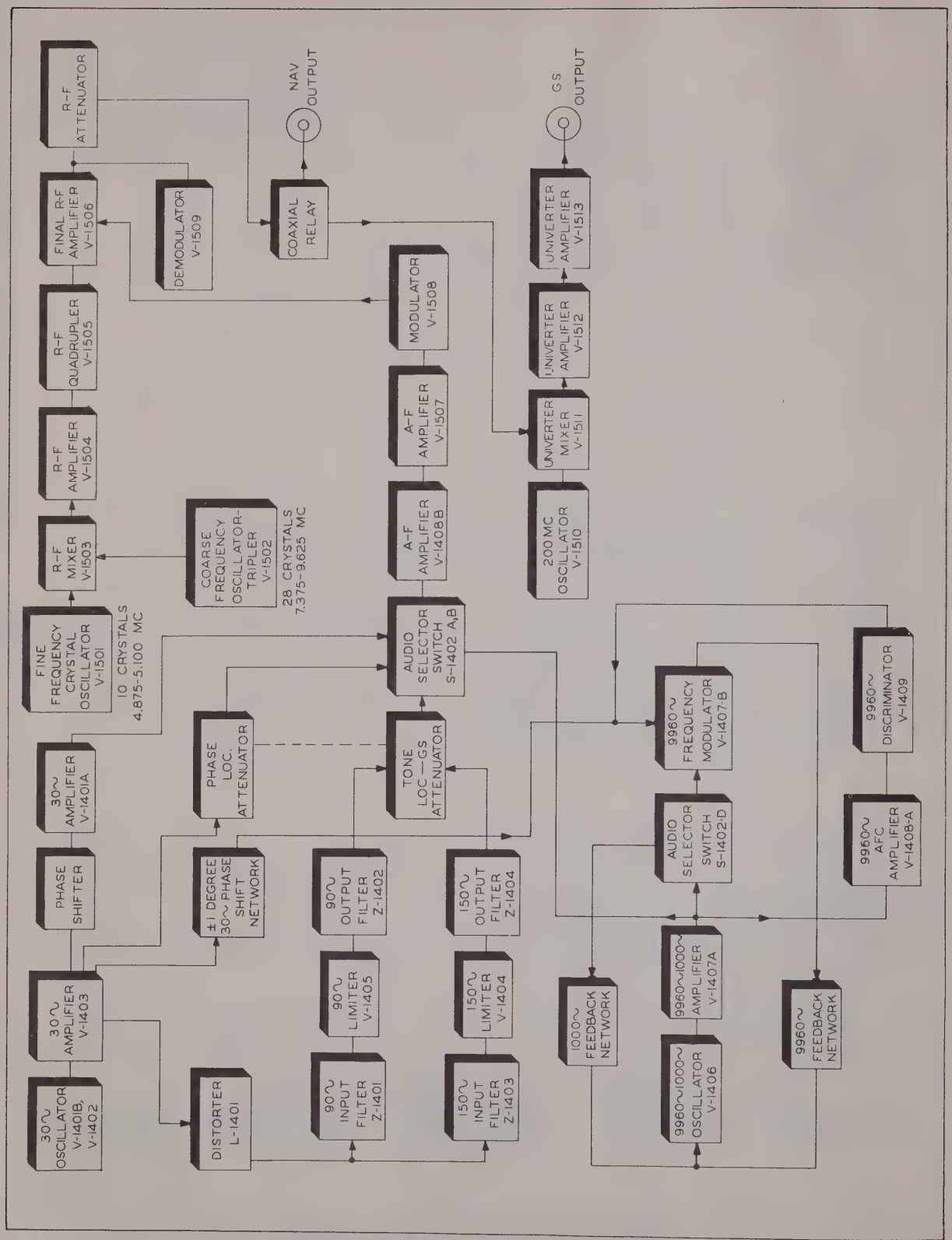


Figure 3-1. Signal Generator SG-13/ARN, Functional Block Diagram

SECTION III

THEORY OF OPERATION

3-1. GENERAL SYSTEM OPERATION.

3-2. The r-f section of the unit supplies the r-f carrier by mixing the outputs of two crystal controlled oscillators and multiplying the sum frequency to the desired 108.0 to 135.9-mc output frequency. (See figure 3-1.) The various audio signals required for modulating the r-f carrier are generated in the audio section by stable RC oscillators and fed to the audio selector switch. R-F output in the 329.3 to 335.0-mc range is obtained by mixing the 129.3 to 135.0-mc signal with a 200-mc signal from a crystal controlled injection oscillator in the univerter.

3-3. DETAILED CIRCUIT OPERATION.

3-4. 30 CPS OSCILLATOR. The 30 cps oscillator is an RC type oscillator using three stages each having a gain of approximately two. See figure 9-1. These stages are coupled by phase shifting networks consisting mainly of C-1401, R-1401, C-1402, R-1405, and C-1403, R-1408. The phase shifting networks have 60° phase shift per section at 30 cps and a total of 180° phase shift. The net phase shift introduced by the three tube sections is also 180°, thus, when the output of V-1402B is fed back to the grid of V-1401B the feedback is in phase and the circuit operates as a 30 cps oscillator. Dual potentiometer R-1410 in the interstage RC coupling circuits allows approximately ±1 cps change in the 30 cps frequency and provides the front panel 30 ~ FREQUENCY adjustment. Each of the phase shifting networks has a temperature compensating network connected in series with it. The parallel combination of R-1580 and R-1581, for example, is used to temperature compensate the C-1401, R-1401 phase shifting network. R-1581 is a negative temperature coefficient resistor which is connected in parallel with R-1580, a resistor having a negligibly low

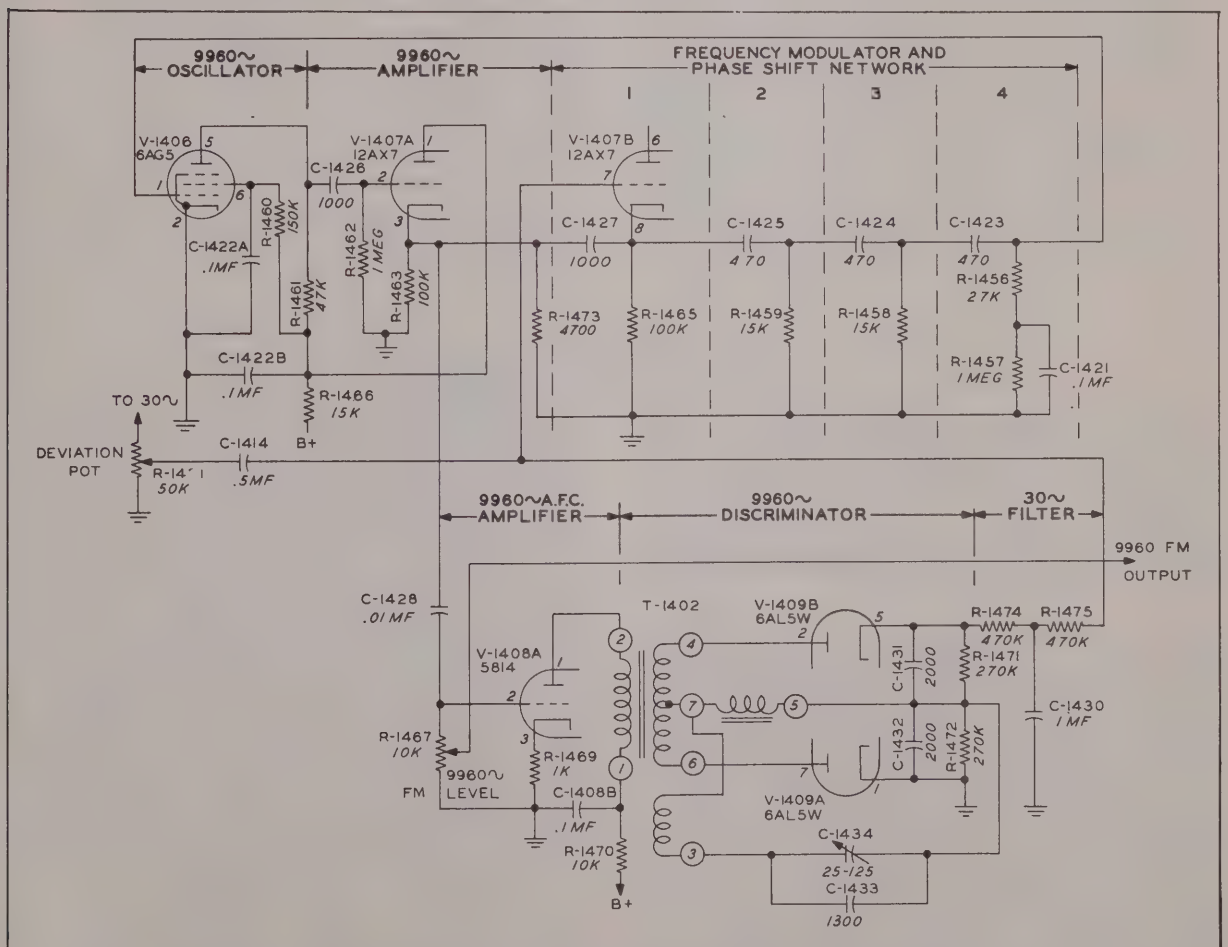


Figure 3-2. Signal Generator SG-13/ARN, 9960 FM Oscillator Circuit, Simplified Schematic

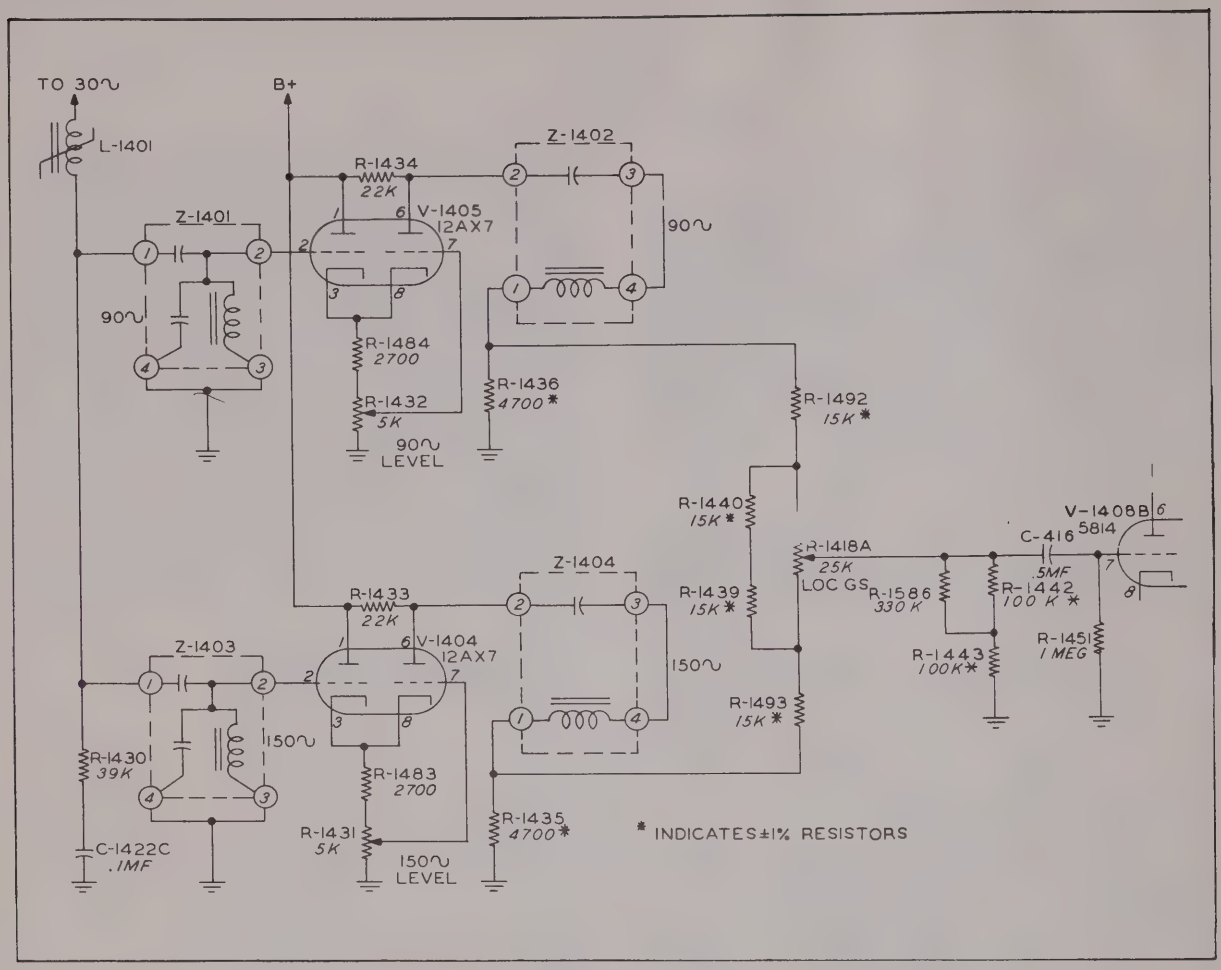


Figure 3-3. Signal Generator SG-13/ARN, Simplified 90-150 CPS Circuit, Audio Selector on GLIDE SLOPE

temperature coefficient. The combination of R-1580 and R-1581 has just enough negative temperature coefficient to offset the inherent positive temperature coefficient of C-1401. This balance prevents the oscillator frequency from varying appreciably with temperature change. Output of the oscillator is fed to the input of V-1403, a push-pull amplifier driving 30-cps output transformer T-1401.

3-5. 9960 FM OSCILLATOR. This oscillator generates a 9960 cps signal frequency modulated at 30 cps. See figure 3-2. If a signal is applied to the grid of V-1406, the amplified signal in the plate circuit will be shifted by 180°. If this signal is shifted another 180° and applied back to the grid of V-1406 in phase with the original signal, oscillations will occur. In this oscillator the signal from the plate of V-1406 is applied through a cathode follower to a four section phase shifting network connected back to the grid of V-1406. The phase shift through the entire four sections is 180° at 9960 cps. Hence oscillations occur at this frequency. If the value of any resistor in the network is changed the frequency of oscillation will change. The first phase shift section is made up of C-1427 and the resistive network consisting of R-1465 in parallel with the output impedance of V-1407B. Any change in the output impedance of V-1407B would cause the frequency of oscillation to change. By applying a 30 cps signal to the grid of V-1407B, the output impedance is changed at a 30 cps rate and hence the frequency of oscillation of the 9960 cps oscillator rises and falls at a 30 cps rate. Sufficient 30 cps signal is applied to the grid of V-1407B to cause the frequency to rise and fall 480 cps from the 9960 cps center frequency. * The amount of 30 cps signal applied is controlled with the DEVIATION potentiometer R-1421. The 9960 cps center frequency is stabilized by adjusting the d-c voltage on the grid of V-1407B automatically, thereby holding the output impedance at the proper center value. To accomplish this, oscillator output is taken from the cathode of V-1407A and applied to the grid of V-1408A which serves as an AFC amplifier. The discriminator circuit, consisting chiefly of discriminator transformer T-1402 and rectifier V-1409 developes a d-c output

* This represents a deviation ratio of 16 where deviation ratio $= \frac{\text{deviation from center freq}}{\text{modulating freq}} = \frac{480 \text{ cps}}{30 \text{ cps}} = 16$

voltage from the AFC amplifier signal whenever the center frequency of the input signal varies from the 9960 cps center frequency. This d-c voltage, positive or negative depending on the direction of error, is filtered to remove the 30 cps component and applied to the grid of modulator tube V-1407B through R-1474 and R-1475.

3-6. The 30 cps reference voltage which frequency modulates the 9960 cps FM signal can be shifted in phase ± one degree. This allows a one degree increment to be placed on any azimuth selected on the VOR switch. The 30 cps reference voltage is obtained from terminal 8 of T-1401 and applied to an RC network whose constants can be changed by operating the ±1 DEGREE switch. The shifted reference voltage appears across the DEVIATION potentiometer R-1421.

3-7. The 1000 cps signal for checking the aural output of a receiver is obtained from the 9960 cps oscillator by switching in a 1000 cps feedback network in place of the 9960 cps network. The frequency modulator is disconnected and the AFC is inoperative when the oscillator is operating at 1000 cps.

3-8. GLIDE SLOPE CIRCUIT. See figure 3-3. The 90 and 150 cps signals for glide slope and localizer operation are generated by distorting the 30 cps signal and selecting the third and fifth harmonics by means of filters. Considerable 30 cps voltage is applied across L-1401, a small audio reactor whose core is insufficiently large for the level involved and consequently saturates. This saturation causes the voltage drop across R-1430 and C-1422C to be distorted and very rich in harmonics. The 3rd and 5th harmonics are separated with filters Z-1401 and Z-1403 and applied to cathode-coupled limiters V-1405 and V-1404. The output level of the limiters is controlled by a potentiometer in each cathode circuit. Further filtering is provided by filters Z-1402 and Z-1404. The 90 and 150 cps voltages of constant amplitude appearing across R-1436 and R-1435 are connected to the LOC-GS attenuator. When the LOC-GS control is set in the middle of the white center sector on the front panel, equal amounts of 90 and 150 cps signal appear at the grid of V-1408B. The amplitude of 90 and 150 cps signals here is such that each signal will modulate the r-f carrier 40%. When the control is rotated to the top line on the left segment, the 90 cps level will fall and the 150 cps level will rise until the 150 cps voltage is 3.0 db higher than the 90 cps voltage. If the control is set on the bottom line there is a 3.75 db difference. On the right segment the situation is reversed and the 90 cps level becomes greater than the 150 cps level.

3-9. TONE LOCALIZER. The 90 - 150 cps circuit is practically the same on TONE LOC as it is on GLIDE SLOPE. Some resistor values in the LOC-GS attenuator are changed by switching. See figure 3-4. The 15,000 ohm resistors on each side of R-1418A in the glide slope circuit are replaced with 2200 ohm resistors in the tone localizer circuit. The 90 and 150 cps levels at the center position of the LOC-GS control are still equal, but when the control is set to the top line of the right or left segment the difference in level between the 90 and 150 cps signals is now 6.0 db. At the bottom line of either segment the level difference is now 7.5 db. Since only 20% modulation is required for each tone for an on-course signal in the TONE LOC position, the level applied to the grid of V-1408B is reduced with the voltage divider consisting of R-1586, R-1442 and R-1443.

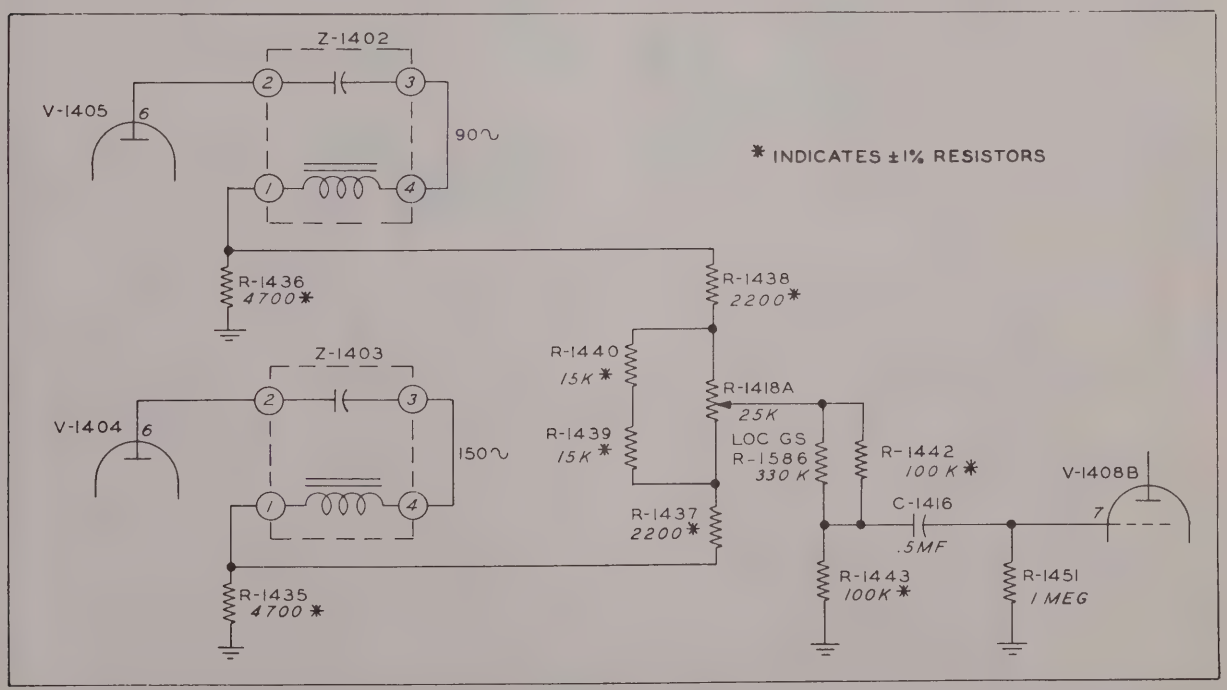


Figure 3-4. Signal Generator SG-13/ARN, Simplified 90-150 cps Circuit, Audio Selector on TONE LOC

3-10. 90 CPS AND 150 CPS. See figure 3-5. The schematic shows the connections in the 90 cps circuit when the AUDIO SELECTOR is set to 90 ∿. Note that the circuit is identical to the Tone Localizer circuit of figure 3-4 with one exception (1) the input grid of V-1404 has been shorted to ground to kill the 150 cps signal. With this connection 20% modulation at 90 CPS is obtained when the LOC-GS control is set in the middle of the white center sector on the panel. In the 150 ∿ position the 90 cps signal is disabled and 20% modulation at 150 cps is obtained when the LOC-GS control is set in the middle of the white center sector on the panel.

3-11. 30 CPS VARIABLE PHASE SHIFTER. Eight azimuth steps are provided in VOR operation. These eight steps spaced 45 degrees apart are obtained by shifting the phase of the 30 cps variable phase signal in an RC phase shifter while maintaining a 30 cps reference signal of constant phase on the grid of the frequency modulator V-1407B. The phase shifter, consisting of R-1422, R-1423, C-1405 and C-1406, is a network so proportioned that the resistance in the circuit is equal to the capacitive reactance. This network is switched by means of S-1401 between various taps on T-1401. See figures 3-6 and 9-1. For example, in the 90 degree position C-1405 and C-1406 are connected to terminal 4 while R-1422 is connected to terminal 7. The output of the network is taken from the center point between R-1423, C-1405 and C-1406 and fed to the grid of the 30 cps variable phase amplifier V-1401A. A 90 degree phase relation exists between the voltage at the grid of V-1401A and the secondary of the transformer for this particular connection. For 270 degrees the network is reversed. For the 45 degree position the network is connected across only one secondary winding of T-1401. For 0 and 180 degrees both ends of the network are connected to either terminal #7 or to terminal #4. This switching results in the required 45 degree steps but causes the output voltage on the grid of V-1401A in some positions to be only .707 of the voltage in the other positions. This variation in level is compensated by selecting taps on the cathode resistor of V-1401A

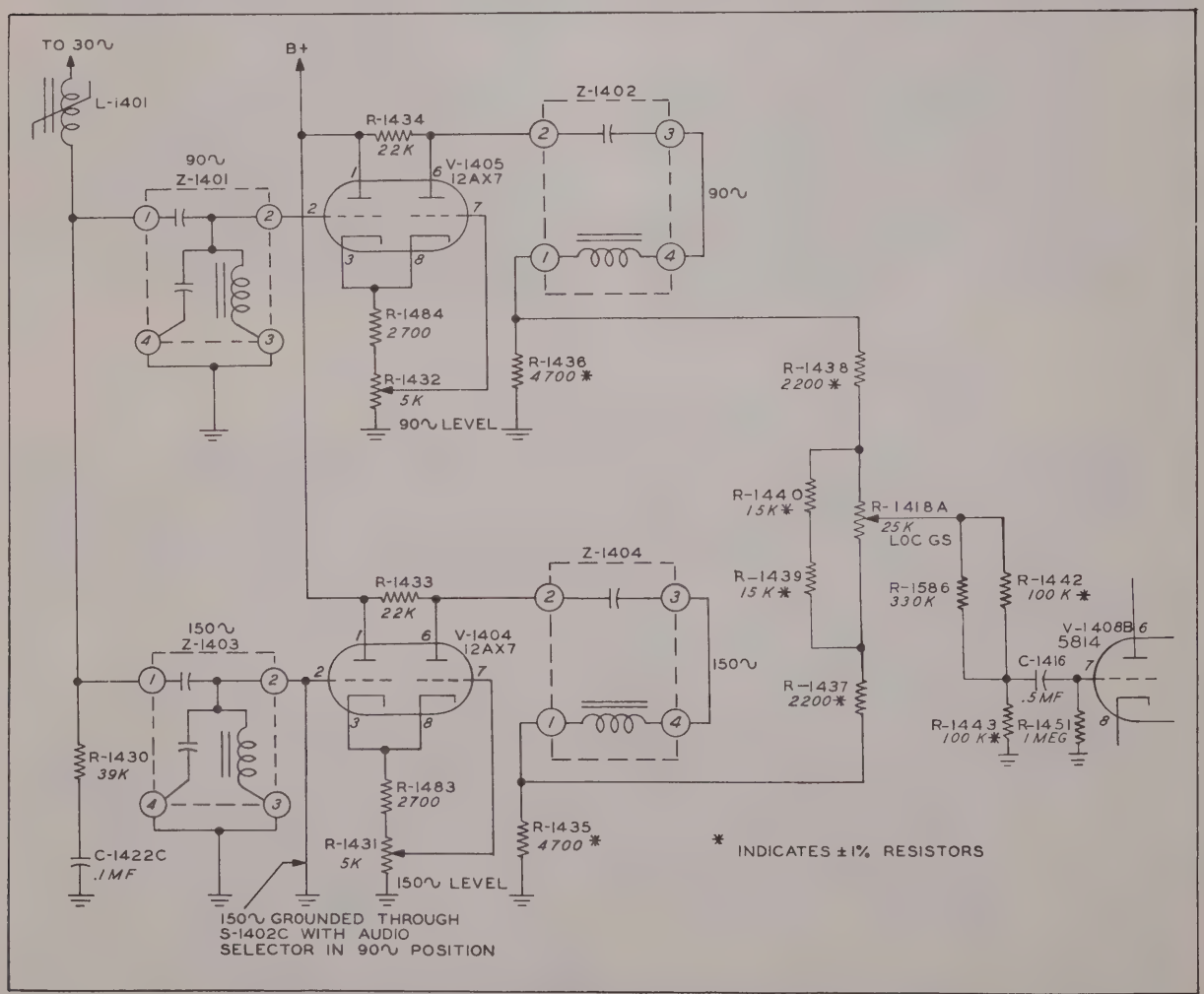


Figure 3-5. Signal Generator SG-13/ARN, Simplified 90-150 cps Circuit, AUDIO SELECTOR on 90 ∿

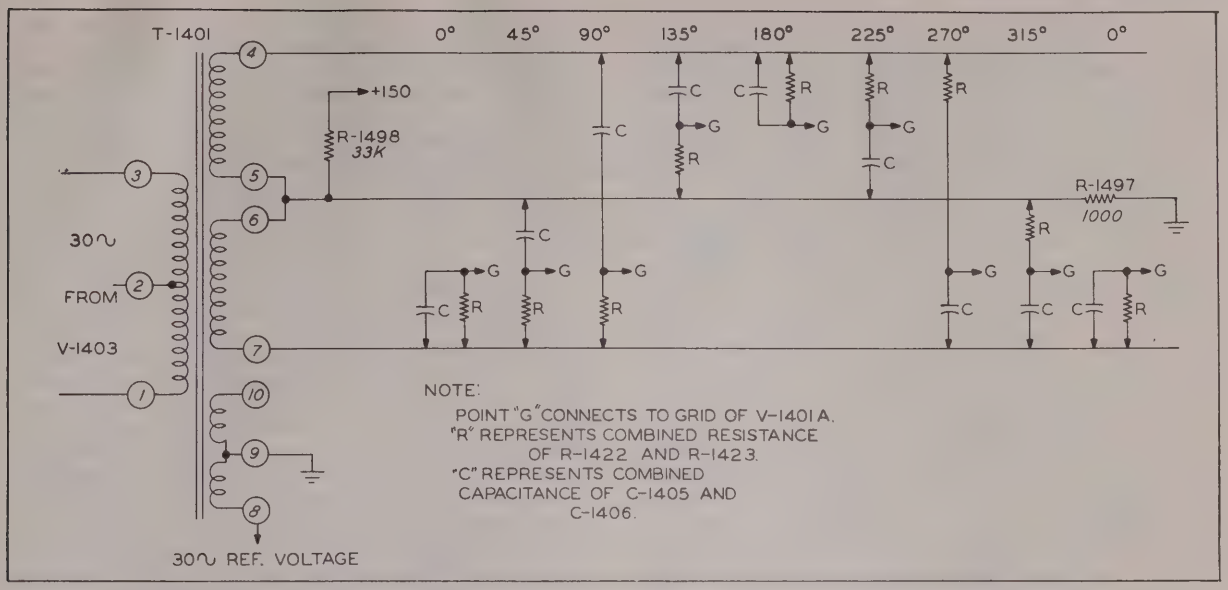


Figure 3-6. Signal Generator SG-13/ARN, 30 CPS Variable Phase Switching Diagram

in such a way as to make the 30 cps output voltage constant for all switch positions. C-1415 and R-1449 comprise the zeroing adjustment for the variable phase signal allowing the VOR zero of the complete instrument to be varied over a narrow range for calibration purposes.

3-12. POWER SUPPLY. The power supply is a 21 volt dynamotor furnishing unregulated B+ and three sources of regulated B+ in conjunction with regulator tubes V-1410, V-1411, and V-1412. See figure 3-7. The three separate regulated voltages are required to keep the audio levels constant and to prevent B+ interaction.

3-13. PHASE LOCALIZER. Phase localizer operation requires a 9960 cps FM signal and a 30 cps signal of reversible phase. The 9960 cps signal is supplied by the 9960 cps FM oscillator described in paragraph 3-5, and the 30 cps reversible phase signal is derived from a bridge circuit connected to one of the secondaries of T-1401. See figure 3-8. The two signals are fed through isolation resistors R-1419 and R-1468 and applied simultaneously to the grid of amplifier V-1408B. The bridge circuit is adjusted with the ∅ LOC CENTER control so that no 30 cps voltage will be applied to the grid of V-1408B when the LOC-GS control is set in the middle of the white center sector on the panel. This simulates an on-course signal. As the LOC-GS potentiometer is turned off center, a 30 cps signal in-phase with the 30 cps reference phase signal or 180 degrees out-of-phase with it will appear on the grid of V-1408B, depending upon the direction of rotation. The amplitude of this 30 cps signal depends on how far off center the LOC-GS potentiometer is set. With the potentiometer set on the top line of either the right or left segment this 30 cps signal should modulate the r-f carrier 11.5%; on the

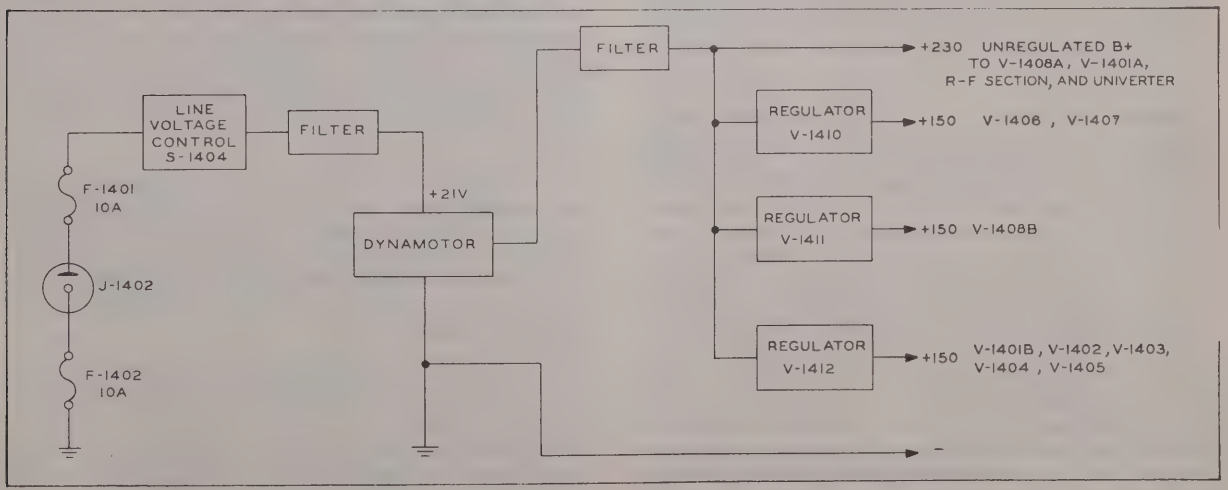


Figure 3-7. Signal Generator SG-13/ARN, Power Supply Block Diagram

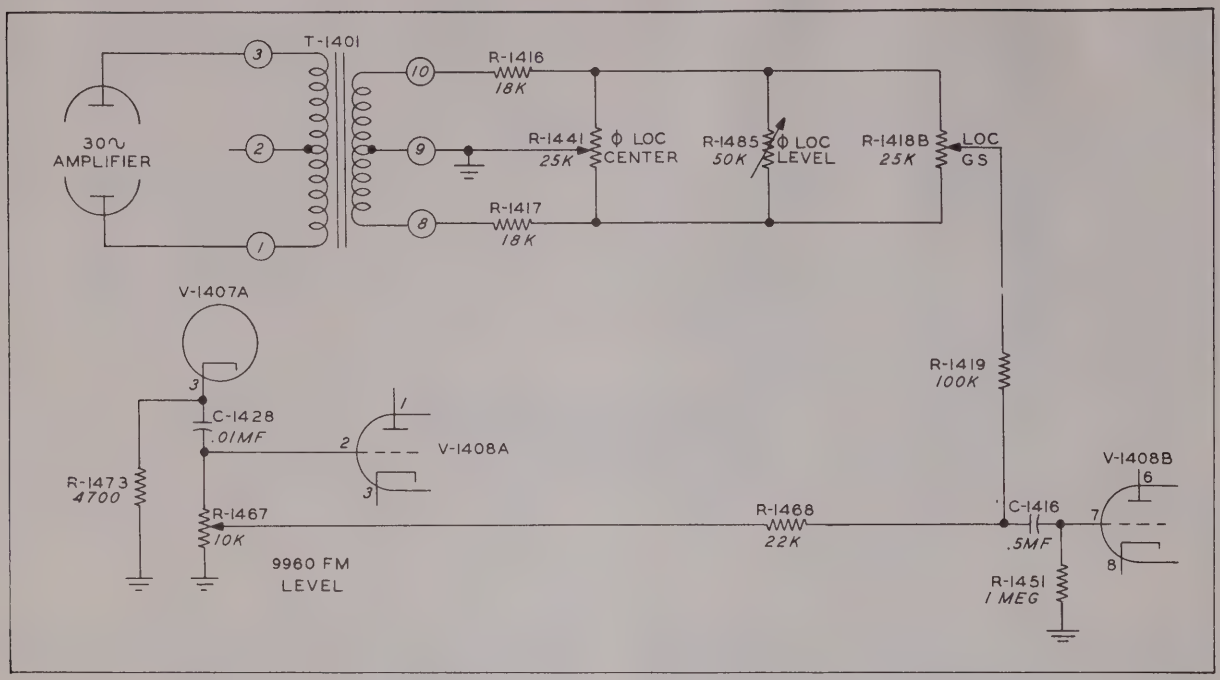


Figure 3-8. Simplified Signal Generator SG-13/ARN, Phase Localizer Circuit

bottom line, the percentage modulation is 14%. This level can be adjusted with the Φ LOCALIZER LEVEL potentiometer. On phase localizer operation, the 9960 FM signal modulates the r-f carrier at a constant 30% modulation regardless of the setting of the LOC-GS potentiometer.

3-14. OUTPUT MIXING AND SWITCHING. In order to combine the various signals generated in the proper proportions to provide the functions desired, it is necessary to mix these signals and switch them to a common output. For the VOR position, 30 cps variable phase and 9960 FM are required. The output level of the 30 cps variable phase signal is adjusted by R-1446 while the 9960 FM output is adjusted with R-1467. Resistors are connected in series with the arms of both potentiometers for isolation. For the Φ LOC position, 9960 FM and 30 cps reversible phase are combined. See figure 3-8. The 30 cps variable phase signal is disabled by shorting the junction of R-1444 and R-1445 to ground through S-1402C. In the TONE LOC position the circuit shown in figure 3-4 exists. Connections for the GLIDE SLOPE position are shown in figure 3-3. It is necessary to set the NAV-GS switch to GS to set up the proper glide slope carrier frequency. In the 1000 ∼ position, the 9960 cycle oscillator has a 1000 cycle phase shift network switched in by S-1402D. The 1000 cycle level is controlled by R-1464. The 30 ∼ VAR Φ position provides a signal useful for calibration since it is the 30 cps variable phase component of the VOR signal. It is obtained by simply omitting the 9960 FM. The 9960 FM position is the other half of the VOR signal and is obtained in a similar manner. In the 90 ∼ position the 150 ∼ is disabled by shorting the grid of the 150 cps limiter to ground through S-1402C. See figure 3-5. In the 150 ∼ position the reverse situation takes place. Mixed signals from the switching network are fed to the grid of V-1408B, an amplifier common to all signals.

3-15. METERING CIRCUIT. Meter M-1401 is provided on the front panel for measuring the unregulated B+ voltage, the adjusted line voltage, and the carrier level. The meter has a zero to 200 microampere movement and it is converted to a 0-30 V d-c voltmeter by means of multiplier resistor R-1482. A voltage divider R-1476-R-1477 provides a 10:1 reduction in the unregulated B+ voltage so that it can be measured by the 0-30 volt voltmeter. Meter switch S-1403 selects the various meter functions. In the CAR position, the meter is connected to the output of the demodulator circuit in the r-f section and to R-1480 which is used to zero the meter when no r-f signal is applied to the demodulator.

3-16. NAV-GS SWITCH. In the GS position, B+ is applied to the univerter and is removed from regulator tube V-1410 which supplies the 9960 FM circuits in order to lower the load on the dynamotor. The switch also operates coaxial relay K-1401 which switches the r-f output of V-1506 from the NAV OUTPUT jack to the univerter input.

3-17. RF GENERATOR SECTION. Carrier frequencies spaced 100 kc throughout the range 108.0-135.9 mc are generated in the shielded r-f assembly. For GS operation, these signals are fed into a univerter which simply adds 200 mc to the input frequency. The univerter has unity gain throughout the GS band of

329.3 to 335.0 mc. The r-f generator in the shielded r-f assembly is crystal controlled by 38 crystals in two oscillators, the coarse frequency oscillator and the fine frequency oscillator. V-1501, the fine frequency oscillator, is a twin triode, the first section of which is connected as a Colpitts oscillator, while the second section is a cathode follower acting as a buffer stage. V-1502, the coarse frequency oscillator has 28 crystals with frequencies of 7375 to 9625 kc. Crystal frequencies are tripled in the output of this oscillator, thus the r-f output is varied through the range 22.125 to 28.875 mc in 28 steps as the outer dial of the MEGACYCLES control is turned. The output of the fine frequency oscillator with 10 frequencies in the range 4875 to 5100 kc is added to the coarse frequency oscillator output in mixer V-1503. The desired sum frequencies at the mixer output range from 27.000 mc to 33.975 mc depending on the setting of the MEGACYCLES control. Output from the mixer is amplified in V-1504 and then fed into quadrupler V-1505. The quadrupler feeds the final amplifier, V-1506. R-f voltage appearing across the tank circuit of V-1506 is applied to the grid of demodulator V-1509, an infinite impedance detector in one section followed by a cathode follower in the other section. The d-c voltage appearing at the cathode of the second section of V-1509 is proportional to the r-f voltage on the grid of the first section. This cathode voltage is fed over into the audio chassis where it actuates the metering circuit. The audio voltages obtained from the demodulator appear at the AUDIO OUT connector on the front panel of the instrument.

3-18. CRYSTAL SELECTOR TUNING. Two concentric MEGACYCLES control knobs control the frequency selection and tuning of the entire r-f section. The large outer knob switches crystals in the coarse frequency oscillator to vary the r-f output frequency in megacycle steps. The coarse frequency oscillator crystals are arranged in two banks, one containing crystals for even megacycles positions, the other containing crystals for odd megacycle positions. Turning the large knob rotates a shaft and selects a crystal in one bank or the other depending on whether the selected megacycle frequency is odd or even. This is accomplished by means of switch S-1503 which opens relay K-1501 on odd megacycle positions and closes it on even megacycle positions. Tuning the large knob also actuates a slug rack which varies the tuning of the seven coils in the r-f section. Powdered iron cores, fastened to the slug rack, are moved in or out of the RF coils in steps of approximately 0.015 inch for each megacycle change in the setting of the large knob. Thus the tuning of all r-f coils is automatically varied in approximately one-megacycle steps to maintain proper tracking as the frequency is varied in one-megacycle steps. The small inner knob on the MEGACYCLES control varies the r-f output frequency in 0.1-mc steps by switching crystals in the fine frequency oscillator. The small knob is mounted on a shaft concentric with the large outer knob and shaft. This inner shaft goes directly to the fine frequency oscillator and switches in the desired crystal. The pass band of the mixer and following r-f stages is sufficiently wide so that no retuning of the slug rack is necessary over the megacycle spread represented by the fine frequency crystals.

3-19. RF ATTENUATOR. The r-f attenuator is of the piston type and is mounted in such a fashion that its small single-turn pickup loop may be moved with respect to the final output coil to vary the coupling and thus the r-f output. This motion of the piston and loop is produced by a rack and pinion drive mechanism. One end of the pickup loop is at ground potential. The other end of the pickup loop is connected to a resistor of approximately 53-ohms contained within the attenuator piston. This resistor in turn is connected in series with the attenuator output cable. With the NAV-GS switch in the NAV position, the r-f attenuator output is connected to the NAV output connector. Thus the NAV output connector provides an r-f voltage source with 53-ohm internal impedance. Since one side of this voltage source is at ground potential, there exists what is commonly referred to as a 53-ohm unbalanced source. With the NAV-GS switch in the GS position, output is obtained at the GS output connector from a tap on the univerter output coil. This also provides a 53-ohm unbalanced source of r-f voltage. Both the NAV and GS output circuits are specifically designed for direct connection to radio receivers having an unbalanced input circuit of approximately 53-ohms impedance. The SG-13/ARN MICROVOLTS dial is calibrated to indicate the r-f voltage induced in the attenuator pickup loop, i.e., the "open-circuit" voltage of the signal generator. This means that when the SG-13/ARN NAV or GS output jack is directly connected to a receiver with a 53-ohm unbalanced input, the MICROVOLTS dial will be direct reading in making all receiver sensitivity measurements. For example, if a receiver test required a 2000-microvolt signal, simply set the SG-13/ARN MICROVOLTS dial to 2000. Radio receivers having a 95-ohm balanced input circuit may be tested with the SG-13/ARN if a UG-529/U adapter is connected between the NAV or CS jack and the receiver input terminals. This adapter is used as an impedance-matching device to match the 53-ohm output impedance of the SG-13/ARN to the 95-ohm input impedance of the receiver. The adapter also has the effect of a 6-db attenuator pad because it reduces the effective r-f output of the SG-13/ARN by one-half. Under these conditions, the MICROVOLTS dial is no longer direct reading in making receiver sensitivity measurements. For example, to set up a 2000 microvolt signal, the SG-13/ARN MICROVOLTS dial must be set at 4000.

3-20. UNIVERTER. In the GS position of the NAV-GS switch, the output of the r-f attenuator is switched by means of coaxial relay K-1401 to the input of the univerter. This input signal in the range 129.3-135.0 mc is coupled into the input coil and applied to mixer V-1511. A 200-mc signal from injection oscillator V-1510 is coupled into the mixer through L-1524 in the mixer cathode circuit. These two frequencies are added in the mixer and fed to two stages of amplification, V-1512 and V-1513. The coupling circuits between stages are overcoupled to have a broad response and pass all signals in the range 329.3-335.0 mc equally well. The gain of the univerter is controlled by varying the screen voltage on V-1512 with potentiometer R-1544.

3-21. SHIELDING. The 108.0 to 135.9 mc r-f unit is contained in an aluminum shield which is insulated from the panel and audio chassis as well as from the r-f chassis within which it is contained. This insulation is necessary to minimize r-f leakage and is broken only at a few carefully selected points. Power leads and detector output leads are brought out of the r-f unit through a filter assembly consisting of five sections; four of these are in use, one is a spare. This filtering is required to prevent radiation from the unit on the external leads.

SECTION IV

PERIODIC INSPECTION AND MINOR REPLACEMENT AND REPAIR

4-1. PERIODIC INSPECTIONS.

4-2. PRE-OPERATION INSPECTION. Make the following check on Signal Generator SG-13/ARN immediately preceding each operation period.

a. Turn SET LINE TO 21V control to OFF position and check mechanical zero of meter with SG-13/ARN in normal operating position.

b. Connect Power Cord CX-1095/U or CX-1506/U to the 21VDC-29VDC connector on SG-13/ARN and to the 21-29 volt source of power.

c. Turn METER switch to LINE position and turn SET LINE TO 21V switch until the meter reads 21 ± 0.5 volts.

d. Turn METER switch to B+ position and read B+ voltage on meter. Reading should be 230 volts. Allow 3 minutes warm up.

e. With METER switch in CAR position and CARRIER SET control fully counterclockwise adjust METER ZERO control until the meter reads zero.

f. Rotate MICROVOLTS dial to 200,000 microvolts and set the METER switch in the CAR position. At each MEGACYCLES dial setting at which the SG-13/ARN is to be used set meter to red line with CARRIER SET control. If the meter cannot be set to the red line, faulty operation of the r-f section is indicated. Refer to Section VI, Trouble Shooting and Correction for corrective procedure.

4-3. INTERMEDIATE INSPECTION (not to exceed 100 hours).

4-4. OVERALL OPERATIONAL CHECK.

a. Perform Pre-Operation Inspection, checking to see if the unit can be red lined at each megacycle step from 135.5 down to 108.5.

b. At 108 MC check operation of all fine frequency oscillator crystals by rotating the tenth-megacycle selector of the MEGACYCLES control through all 10 positions and observing if the unit can be red lined at each setting.

c. Connect a cathode ray oscilloscope to the AUDIO OUT connector.

d. Set the AUDIO SELECTOR switch to each of its settings and check the wave forms obtained per paragraphs 6-10 through 6-18. Excessive distortion may be an indication of a defective tube or component in the audio section. Noise or ripple on the wave forms is often an indication of defective dynamotor operation. See Section VI, paragraph 6-20.

4-5. VOR ACCURACY CHECK.

a. Connect the SG-13/ARN through a 6-db, 53-ohm attenuator pad to an ARN-14 navigation receiver equipped with omni bearing selector (OBS) and a precision crosspointer meter. Set the frequency of the signal generator and receiver to 114.9 mc. Set NAV-GS switch to NAV. Allow SG-13/ARN to warm up at least 15 minutes and adjust SET LINE TO 21V control for 21V ±0.5V on panel meter. Set METER ZERO and adjust carrier level to red line. See figure 8-5, part 2 for connections.

b. Set the SG-13/ARN AUDIO SELECTOR on VOR, the VOR switch to 0°, and the MICROVOLTS dial to 1000.

c. Adjust the SET control on Indicator ID-249A until the crosspointer is centered at the setting of approximately 0° and the TO-FROM indicator reads TO.

d. Disconnect the SG-13/ARN and substitute a modulator MD-83/ARN modulating an SG-1/ARN signal generator with a standard VOR signal. Use the same 6-db pad at the receiver input. See figure 8-5, part 1 for connections.

e. Set the SG-1/ARN microvolts dial to 500. Vary the MD-83A/ARN VOR dial setting until the crosspointer is again centered with the TO-FROM indicator reading TO.

f. Subtract the SG-13/ARN VOR switch setting from the MD-83A/ARN VOR dial setting to obtain the VOR error.

g. Repeat steps a through f for each setting of the SG-13/ARN VOR switch. VOR error should not exceed ±0.7 degree at any setting of the VOR switch.

4-6. TONE LOCALIZER CENTERING ACCURACY CHECKS.

a. Connect an SG-1/ARN signal generator modulated with an MD-83A/ARN to an ARN-14 navigation receiver equipped with a precision crosspointer meter. Use a 6-db, 53-ohm attenuator pad at the receiver input. See figure 8-5.

b. Set the frequencies of the receiver and signal generator to 110.1 mc, and set the MICROVOLTS dial of the signal generator to 500.

c. Modulate the SG-1/ARN with a zero db tone localizer signal and adjust receiver for zero crosspointer current. (Consult receiver handbook for location of adjustment.)

d. Substitute the SG-13/ARN for the MD-83A/ARN, SG-1/ARN combination using the same 6-db pad, and set the MEGACYCLES control to 110.1. Allow SG-13/ARN to warm up at least 15 minutes and adjust SET LINE TO 21V switch for 21V ± 0.5V on panel meter. Set METER ZERO and adjust carrier level to red line.

e. Set the MICROVOLTS dial to 1000 and set the SG-13/ARN for an "ON COURSE" tone localizer signal (LOC-GS control to top center panel mark). The crosspointer current reading should be 0 ± 8 microamperes.

4-7. TONE LOCALIZER 6-DB ACCURACY CHECK.

a. Repeat steps a and b of paragraph 4-6.

b. Modulate the SG-1/ARN with a 4-db LEFT tone localizer signal from MD-83A/ARN and adjust the navigation receiver for 90 microamperes crosspointer current. (Consult receiver handbook for location of adjustment.)

c. Substitute the SG-13/ARN for the MD-83/ARN, SG-1/ARN combination and set its frequency to 110.1 mc.

d. Set the MICROVOLTS dial to 1000 and set the SG-13/ARN for a 6-db LEFT tone localizer signal. (Top mark on the course width sector.)

e. The crosspointer current should be 135 ± 15 microamperes.

f. Repeat steps b, c, d and e for a 6-db RIGHT tone localizer setting.

4-8. GLIDE SLOPE CENTERING ACCURACY CHECK.

a. Connect an SG-2 signal generator through a 6-db 53-ohm attenuator pad to an ARN-18 glide slope receiver equipped with a precision cross pointer meter. See figure 8-6, part 1.

b. Set the frequencies of the signal generator and receiver to 332.0 mc and set the SG-2 microvolts dial to 500.

c. Modulate the SG-2 with a zero db glide slope signal and adjust the receiver for zero crosspointer current. (Consult receiver handbook for location of adjustment.)

d. Using the same 6-db pad, substitute the SG-13/ARN for the SG-2 and set its frequency to 332.0 mc. See figure 8-6, part 2.

e. Set the SG-13/ARN MICROVOLTS dial to 1000 and set the SG-13/ARN for an "ON COURSE" glide slope signal (LOC-GS control to top center panel mark). The crosspointer current reading should be 0 ± 12 microamperes.

4-9. GLIDE SLOPE 3-DB ACCURACY CHECK.

a. Repeat steps a and b of paragraph 4-8.

b. Modulate the SG-2 with a 2-db UP glide slope signal and adjust the ARN-18 glide slope receiver for 90 microamperes crosspointer current. (Consult receiver handbook for location of adjustment.)

c. Substitute the SG-13/ARN for the SG-2 and set the SG-13/ARN frequency to 332.0 mc.

d. Set the SG-13/ARN MICROVOLTS dial to 1000 and set the SG-13/ARN for a 3-db UP glide slope signal. (Top mark on the course width sector.)

e. The crosspointer current should be 135 ± 18 microamperes.

f. Repeat steps b, c, d and e for a 3 db DOWN setting.

4-10. Failure of the SG-13/ARN to meet the above VOR, TONE-LOC, and GS accuracy requirements usually indicates that one or more of the audio signals involved is not set to the correct frequency or percentage modulation. Excessive distortion can also cause inaccuracy.

4-11. MAJOR INSPECTION. (Not to exceed 500 hrs).

a. Remove SG-13/ARN from case.

b. Remove top and bottom covers from RF chassis and clean inside with a soft brush or vacuum cleaner.

c. Check the signal generator and dynamotor for mechanical damage, loose parts, and signs of overheating and corrosion.

d. Check the dynamotor brushes for a minimum length of 1/4 inches. Replace if necessary. See Section VII, paragraph 7-16.

e. Check the dynamotor commutator for evidences of grooving or pitting. Dress or replace if necessary. See Section VII, paragraph 7-17.

f. Lubricate equipment as follows:

AN-G-25 GREASE

Part	Location	Amount
Dynamotor bearings	Each end of unit	Small amount See par. 7-22 Section VII
Attenuator Spur Gear	(10) figure 7-5	Small amount on gear teeth
Attenuator plunger drive rack	(5) figure 7-5	Small amount on top and sides

AN-O-4 OIL (AN-O-6A, Alternate)

Part	Location	Amount
CARRIER SET control shaft bushing	(8) figure 7-1	One drop if binding or squeaking occurs.
Attenuator MICROVOLTS control shaft bushing	(7) figure 7-1	One drop if binding or squeaking occurs
R-f slug rack oil retaining felt washers	(8)(9) figure 7-2	One drop
Attenuator Spur Gear shaft bushing	(12)(13) figure 7-5	One drop if binding or squeaking occurs

g. Check alignment of the r-f and audio sections as outlined in Section VIII and realign where necessary. (Refer to minimum performance standards in Section VI, paragraph 6-20.)

h. With chassis covers replaced, secure chassis in case and perform the intermediate inspection as outlined in paragraph 4-3 above.

4-12. SPECIAL INSPECTION. (2000 hours)

a. Replace all tubes in the equipment.

b. Perform the Major Inspection as outlined in paragraph 4-12 above.

4-13. REPLACEMENT OF VACUUM TUBES.

a. All tubes are of the miniature type. Remove by pulling straight out of socket, taking care not to bend the base pins. See figure 4-1 for tube location.

b. Thoroughly test a suspected tube before discarding. If replacement tube does not correct operation, always re-insert the original tube.

NOTE

In the event that tubes are changed, check the associated circuit functioning for proper alignment. Univerter tube changes may considerably affect univerter alignment due to the high frequencies involved.

CAUTION

Do not remove tubes with power applied to the equipment. Heaters are wired in various series - parallel combinations and removal of one tube may overload and burn out other heaters. See figures 9-1 and 9-2 for heater circuits.

4-14. REPLACEMENT OF FUSES.

a. The power input line is protected by two 10 amp fuses mounted on the front panel. To remove, turn cap to unlock and pull fuse from holder.

CAUTION

Never replace a fuse with one of higher rating unless continued operation is of such importance as to warrant possible damaging of the equipment.

b. If a replaced fuse blows immediately, investigate circuits before further replacement.

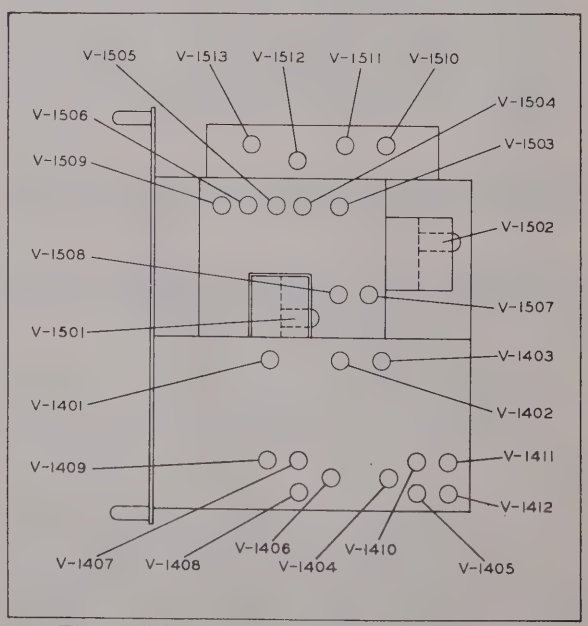


Figure 4-1. Signal Generator SG-13/ARN
Top View, Tube Location

SECTION V

SPECIAL EQUIPMENT AND TOOLS

5-1. SPECIAL EQUIPMENT. and align signal Generator SG-13/ARN is
5-2. The test equipment necessary to test listed below.

SPECIFIC TYPES

NAME	AN DESIGNATION	ALTERNATE	APPLICATION
SIGNAL GENERATOR	SG-1/ARN	None	Signal source-NAV frequencies
Power Supply	PP-348/ARN		Power for SG-1/ARN
Power Cord	CX-237/U		PP-348/ARN line cord
Power Cable Assembly	CX-1290/ARN		Power connector PP-348 to SG-1
R-F Cable Assembly	CG-409/U		SG-1 r-f output cable
Adapter Connector	UG-528/U		6-db pad and adapter CG-409/U to R-540A/ARN-14C
MODULATOR	MD-83A/ARN	None	Audio modulation of SG-1/ARN
R-F Cable Assembly	CG-530/U		MD-83A/ARN to SG-1/ARN connection
Power Cord	CX-237/U		Power line cord
AN/ARN-14 COMPONENTS			
Radio Receiver	R-540/ARN-14C	R-252A/ARN-14	Comparative measurements
Dynamotor	DY-66B/ARN-14C	DY-66A/ARN-14	Power source for receiver
Course Indicator	ID-249A/ARN		Crosspointer and TO-FROM indications
Control Panel	C-760B/A	C-760/A	Receiver Control
SIGNAL GENERATOR	SG-2/GRM-4	None	Signal source GS frequencies
Power Cord	CX-237/U		SG-2 power line cord
R-F Cable Assembly	CG-409/U		SG-2 r-f output cable
Adapter Connector	UG-528/U		6-db pad and adapter CG-409 A/U to R-322/ARN-18
AN/ARN-18 COMPONENTS			
Radio Receiver	R-322/ARN-18		Comparative measurements
BALLANTINE MODEL 300 ELECTRONIC VOLTMETER			Comparative a-c voltage measurements
WESTON MODEL 901 MICROAMMETER			Measure receiver cross-pointer current

GENERAL TYPES

NAME	REQUIRED CHARACTERISTICS
D-C Vacuum Tube Voltmeter•	Functions - D-C Voltmeter, Ohmmeter Input Impedance: 10 megohms Ranges: 3 to 5 volts full scale and three higher ranges to 300 volts

GENERAL TYPES - Cont.

NAME	REQUIRED CHARACTERISTICS
Oscilloscope	Input Impedance: 2 megohms or more 25 uuf or less Frequency Characteristic - Uniform from 20 to 20,000 cps
Audio Oscillator	Frequency range 20 to 15,000 cps Output - 1 volt
Frequency METER	Secondary frequency standard - ±0.001% Range - 5000 - 10,000 Kilocycles

5-3. SPECIAL TOOLS.

5-4. The special tools required to perform maintenance, alignment, and overhaul operations on Signal Generator SG-13/ARN are listed below.

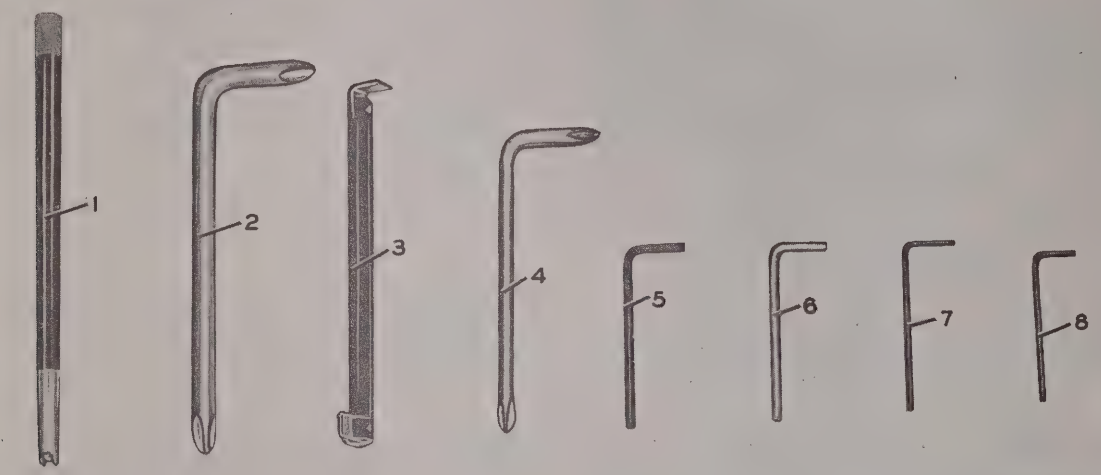


Figure 5-1. Special Tools

PART NUMBER	NAME	APPLICATION	FIGURE 5-1 INDEX NO.
504 6016 001	Tuning Wand	Detuning; Brass end for adjusting C-1529	1
	Phillips Screwdriver #2		2
504 6027 002	Alignment Tool	Adjusting T-1501, Z-1501, T-1502, and trimmer capacitors	3
	Phillips Screwdriver #1		4
	Bristo Wrench #10 set screw		5
	Bristo Wrench #8 set screw		6
	Bristo Wrench #6 set screw		7
	Bristo Wrench #4 set screw		8

SECTION VI

TROUBLE SHOOTING AND CORRECTION

6-1. SECTION ISOLATION.

6-2. It is possible to detect many troubles in Signal Generator SG-13/ARN without removing the instrument from its case. The carrier level is indicated on the meter with the METER switch in the CAR position. It gives evidence of proper operation of the r-f section. Audio signals can be observed with an oscilloscope or a-c vacuum tube voltmeter connected to the AUDIO OUT jack. These audio signals are obtained by demodulating the r-f signal which appears across the final tank circuit and therefore provide a check on the entire modulation process as well as on the audio section. The following chart lists probable trouble symptoms with causes and remedies.

SYMPTOM	PROBABLE CAUSE	REMEDY
CARRIER meter suddenly drops to zero as MICROVOLTS dial is turned to maximum position	Attenuator stop set incorrectly	See Section VIII paragraph 8-4.
R-f output on CARRIER meter varies depending on direction of approach in setting up frequency with the MEGACYCLES control	1. Sticking slug rack	Lubricate, See Section IV paragraph 4-11
	2. Improper adjustment of course frequency oscillator coupler	See Section VII paragraph 7-4
R-f output obtained only on odd positions of MEGACYCLES control	1. Defective K-1501 relay 2. Defective S-1503 switch	Measure d-c voltage on terminal 2 of coarse frequency oscillator. Should read 21V on even mc steps. If not, check switch S-1503
CARRIER meter red-lines but no 108 to 135.9 mc output at NAV connector	1. Normally closed contacts of K-1401 failing to make contact 2. Faulty r-f cables from attenuator to K-1401 and/or from K-1401 to NAV connector.	Check continuity with ohmmeter and replace relay if defective. Check continuity and connections of r-f cables.
CARRIER meter red-lines but no 329 to 335 mc output at GS connector	1. Normally open contacts of K-1401 failing to close when relay is energized. 2. Univerter circuits or r-f connecting cables bad.	Measure voltage across relay terminals with NAV-GS switch on GS. If 21V, check relay for continuity. Replace if defective. Check cables and make voltage and resistance checks in univerter.
MICROVOLTS dial has rough action.	1. Improper alignment between attenuator shaft and front panel control shaft	See Section VII paragraph 7-10
	2. Coupler sections fastened too closely together	Loosen set screws in one or both halves and re-set.
	3. Need of lubrication on shaft bearing points	Apply lubrication, See Section IV paragraph 4-11.
R-F leakage	R-f covers not in place Attenuator tube set screws not tightened Connectors improperly attached to coaxial cables at NAV-GS output or at coaxial relay	Check for proper fit of cover and missing screws Tighten set screws (6) (7) and (8), figure 7-6 Check connectors.

SYMPTOM	PROBABLE CAUSE	REMEDY
Inaccurate R-f output	1. Attenuator pickup loop broken loose at ground end	See figure 8-3 for location and repair if necessary
	2. Defective 51-~resistor in attenuator slider	Check and replace if necessary
	3. Defective coaxial relay	Replace
	4. MICROVOLTS control knob improperly set	See Section VIII paragraph 8-4
Erratic 90 or 150 cps levels	Defective Z-1402 or Z-1404 filters	Check components and replace where necessary
VOR signals inaccurate	1. C-1405, C-1406, or R-1423 defective	Replace where necessary
	2. 30 cps oscillator off frequency	See Section VIII paragraph 8-8
Unable to properly adjust 90 or 150 cps levels	Defective V-1408B, V-1507, V-1508, or V-1506	Check tubes, replace if necessary
METER reads off-scale on CAR position of S-1403	R-1479 open	Replace
GS center or 3-db signals inaccurate after setting up TONE LOC	R-1437, R-1438, R-1492 or R-1493 out of tolerance	Replace

6-3. R-F CIRCUIT TROUBLE SHOOTING.

6-4. VACUUM TUBE CHECK. If the r-f section is inoperative check all tubes. Apply only enough voltage to note whether all tubes light. If some do not light turn the power off, locate and replace the defective tube.

CAUTION

Do not remove tubes when the power is on. Several tubes are connected in series parallel and withdrawing one may burn out one or more.

6-5. CIRCUIT ISOLATION. Measure the voltage on standoff E-1508 at the junction of R-1515 and R-1516 with a 100,000 ohm resistor in series with the probe of a d-c vacuum tube voltmeter. (See grid circuit of V-1506, Figure 9-1.) This voltage should be greater than -1.0 volt over the entire frequency range. If less than -1.0 volt, check the drive on the preceding stages. Measure voltages on the grid of each preceding stage using a 100,000 ohm resistor in series with the d-c vacuum tube voltmeter and compare with the typical measurements listed below:

TUBE	TERMINAL	D-C VOLTAGE
V-1505	Pin #1	-30 v
V-1504	Pin #1	-2.5 v
V-1503	Pin #1	-2.75 v
- - - -	E-1508	-1.4 v

6-6. OSCILLATOR CHECK. The drive on r-f mixer, V-1503, comes from both the coarse frequency and the fine frequency oscillators. While measuring the grid voltage on V-1503, detune the oscillator coils in T-1501 with the tuning wand by inserting the wand into L-1511 (figure 8-1). If the coarse frequency oscillator is operating satisfactorily the grid drive on V-1503 will fall as T-1501 is detuned. If the coarse frequency oscillator is not operating properly the tube and relay K-1501 should be checked before removing the oscillator. The relay can be checked by listening carefully while turning the outer knob on the MEGACYCLES control. A click will be heard as the relay opens or closes each time the frequency is changed. On even megacycle positions the relay should be energized and 21 volts will appear on terminal #2 of the coarse frequency oscillator. The switches inside the oscillator must be oriented properly with the slug table shaft. On the 135.0 mc position one screw on the shaft adapter will be approximately straight up and the other will be on the left side when viewed from the front. (See figure 7-3). The shaft adapter couples the slug table to the switches inside the coarse frequency oscillator. If it is necessary to remove the coarse frequency oscillator from the slug table refer to Section VII, paragraphs 7-2 and 7-3.

6-7. Both the coarse and the fine frequency oscillators can be checked by placing the antenna of a receiver near the lead on terminal #1 of either oscillator and tuning the receiver to the oscillator frequency. See tables of oscillator frequencies versus dial positions below:

TABLE 6-1

FINE FREQUENCY OSCILLATOR

Inner Dial	Crystal Position	Freq. KC
.0	1	4875
.1	2	4900
.2	3	4925
.3	4	4950
.4	5	4975
.5	6	5000
.6	7	5025
.7	8	5050
.8	9	5075
.9	10	5100

TABLE 6-2

COARSE FREQUENCY OSCILLATOR

Outer Dial	Crystal Position	Freq. KC
108	1	7375.000
109	2	7458.333
110	3	7541.667
111	4	7625.000
112	5	7708.333
113	6	7791.667
114	7	7875.000
115	8	7958.333
116	9	8041.667
117	10	8125.000
118	11	8208.333
119	12	8291.667
120	13	8375.000
121	14	8458.333
122	15	8541.667
123	16	8625.000

Table 6-2 (Continued)

COARSE FREQUENCY OSCILLATOR

Outer Dial	Crystal Position	Freq. KC
124	17	8708.333
125	18	8791.667
126	19	8875.000
127	20	8958.333
128	21	9041.667
129	22	9125.000
130	23	9208.333
131	24	9291.667
132	25	9375.000
133	26	9458.333
134	27	9541.667
135	28	9625.000

6-8. AUDIO SECTION TROUBLE SHOOTING.

6-9. WAVE FORM CHECK. Troubles in the audio section may generally be isolated to the faulty circuit by checking wave forms at the AUDIO OUT connector for the various positions of the AUDIO SELECTOR switch. Connect an oscilloscope to the AUDIO OUT connector and compare the waveforms with those shown below.

6-10. VOR. Appears as a wide sine wave band at 30 cps. See figure 6-1.

6-11. ϕ LOC. Same as VOR except smaller 30 cps amplitude. See figure 6-2.

6-12. TONE LOC. Appears as a composite 90 and 150 cps wave. Varies in waveform as LOC-GS control is rotated. See figure 6-4.

6-13. GLIDE SLOPE. Same as TONE LOC except that amplitude is doubled.

6-14. 1000 CPS. Waveform is that of a 1000 cps sine wave.

6-15. 30 CPS VAR ϕ. Wave form is that of a 30 cps sine wave.

6-16. 9960 FM. Appears as a 9960 cps sine wave with the frequency modulation causing a spreading out of the wave form. See figure 6-3.

6-17. 90 CPS. Wave form is that of a 90 cps sine wave.

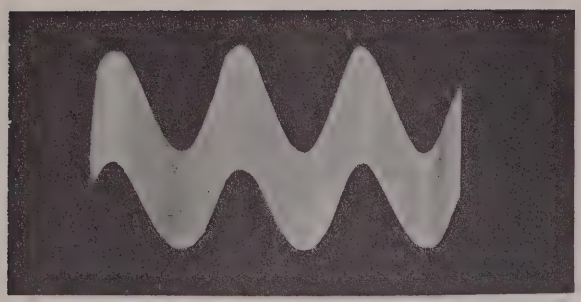


Figure 6-1. Wave form at AUDIO OUT connector with AUDIO SELECTOR on VOR.

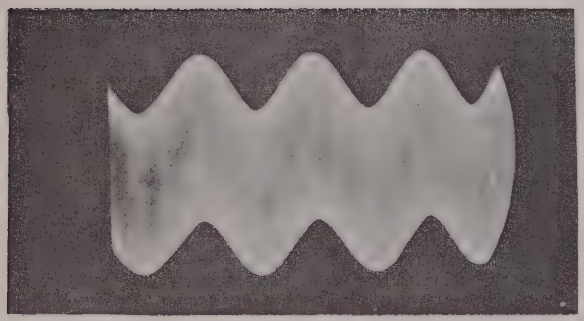


Figure 6-2. Wave form at AUDIO OUT connector with AUDIO SELECTOR on ϕ LOC and LOC-GS Control Set to TOP Line of Right Segment.

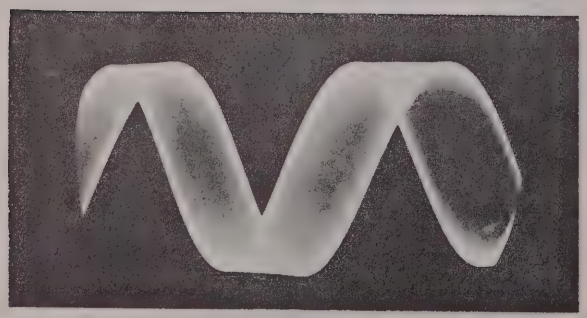
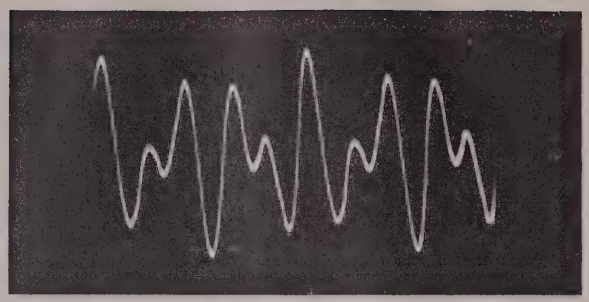
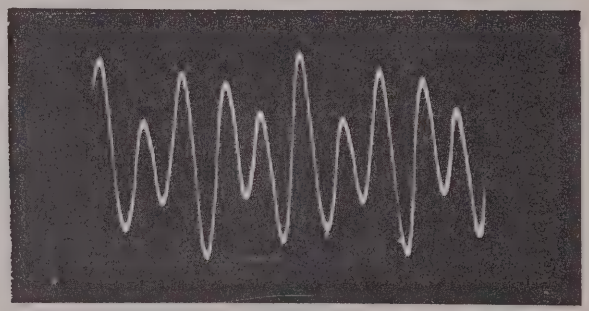


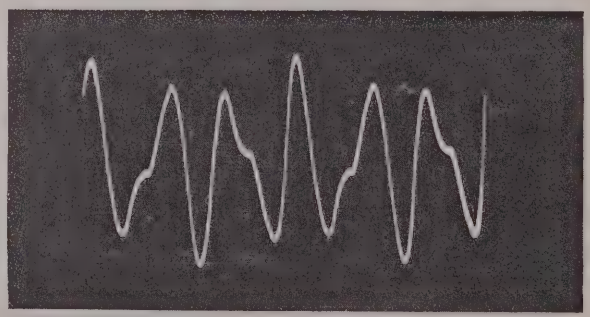
Figure 6-3. Wave form at AUDIO OUT connector with AUDIO SELECTOR on 9960 FM



(a) LOC-GS Control Centered 90 $\sim$ = 150 $\sim$



(b) LOC-GS Control on Top Line of Left Segment. 150 $\sim$ 6db higher than 90 $\sim$



(c) LOC-GS Control on Top Line of Right Segment. 90 $\sim$ 6db higher than 150 $\sim$

Figure 6-4. Wave forms at AUDIO OUT connector with AUDIO SELECTOR on TONE LOC

6-18. 150 CPS. Wave form is that of a 150 cps sine wave.

6-19. VOLTAGE CHECK. The wave form inspection will isolate the trouble to the particular circuit at fault. To isolate the trouble further trace the signal through the faulty circuit with a Ballantine vacuum tube voltmeter or oscilloscope. Refer to the terminal d-c voltage diagrams and table of a-c voltage levels in Section IX.

6-20. MINIMUM PERFORMANCE STANDARDS.

AUDIO FREQUENCY	FREQUENCY TOL	TOTAL HAR. * DISTORTION (*Measured at pin 2, V-1508)
30 ~	± 1%	6%
90 ~	± 1%	8%
150 ~	± 1%	8%

AUDIO FREQUENCY	FREQUENCY TOL	TOTAL HAR.* DISTORTION (*Measured at pin 2, V-1508)
9960 ~	± 2%	10%
1000 ~	±15%	15%
Accuracy of r-f frequencies		±0.0065%
Accuracy of r-f level		±25%
VOR accuracy		±0.7 degrees

6-21. DYNAMOTOR TROUBLE SHOOTING

6-22. Troubles in the dynamotor may be located more readily by reference to chart below. Refer to Section VII for corrective procedures.

SYMPTOM	PROBABLE CAUSE	REMEDY
1. Failure to start.	1. No voltage or improper input voltage.	1. Check source voltage.
	2. "Open" in input circuit wiring or power cable.	2. Check and repair "opens" and loose connections in input circuit.
	3. Defective starting switch.	3. Replace or repair switch
	4. Armature winding may be "open".	4. Return dynamotor to qualified overhaul depot.
	5. Worn low voltage brushes.	5. Replace brushes.
	6. Dirty low voltage commutator.	6. May be due to grease on commutator. Clean with cloth saturated with gasoline or dress the commutator.
2. Excessive speed	1. Shunt field may have short circuited turns on an "open".	1. Return dynamotor to qualified overhaul depot.
3. No output, or low output	1. Poor commutation resulting from a dirty commutator	1. Clean commutator with cloth saturated with gasoline, or dress the commutator.
	2. Low input voltage.	2. Check input circuit for loose connections. Check source voltage.
	3. Shims "end loading" bearings.	3. Return dynamotor to qualified overhaul depot.
	4. Defective armature.	4. Return dynamotor to qualified overhaul depot.

SYMPTOM	PROBABLE CAUSE	REMEDY
	5. Broken or sticking brushes.	5. Replace brushes.
4. Dynamotor noisy mechanically.	1. Dry bearings.	1. Remove bearings and lubricate or replace as necessary. See Section VII
	2. Bent shaft.	2. Return to qualified overhaul depot.
	3. High commutator bar.	3. Return dynamotor to qualified overhaul depot.
	4. Dynamotor mounting not secure.	4. Tighten mounting screws.
5. Overheating	1. Bearings dry or damaged.	1. Remove bearings and lubricate or replace as necessary
	2. Shims "end loading" bearings.	2. Return dynamotor to qualified overhaul depot
	3. Bent shaft rubbing against housing.	3. Return dynamotor to qualified overhaul depot.
	4. Sticking brushes.	4. Replace or service brushes
6. Dynamotor noisy electrically	1. Arcing at brushes, broken or cracked brushes, brushes sticking in holder.	1. Replace or service brushes
	2. High commutator bar, high mica between commutator segments.	2. Return dynamotor to qualified overhaul depot.
	3. Dirty commutator	3. Clean commutator with clean cloth saturated with unleaded gasoline.
7. Vibration	1. Bent shaft.	1. Return dynamotor to qualified overhaul depot.

SECTION VII

OVERHAUL OF MECHANICAL COMPONENTS

NOTE

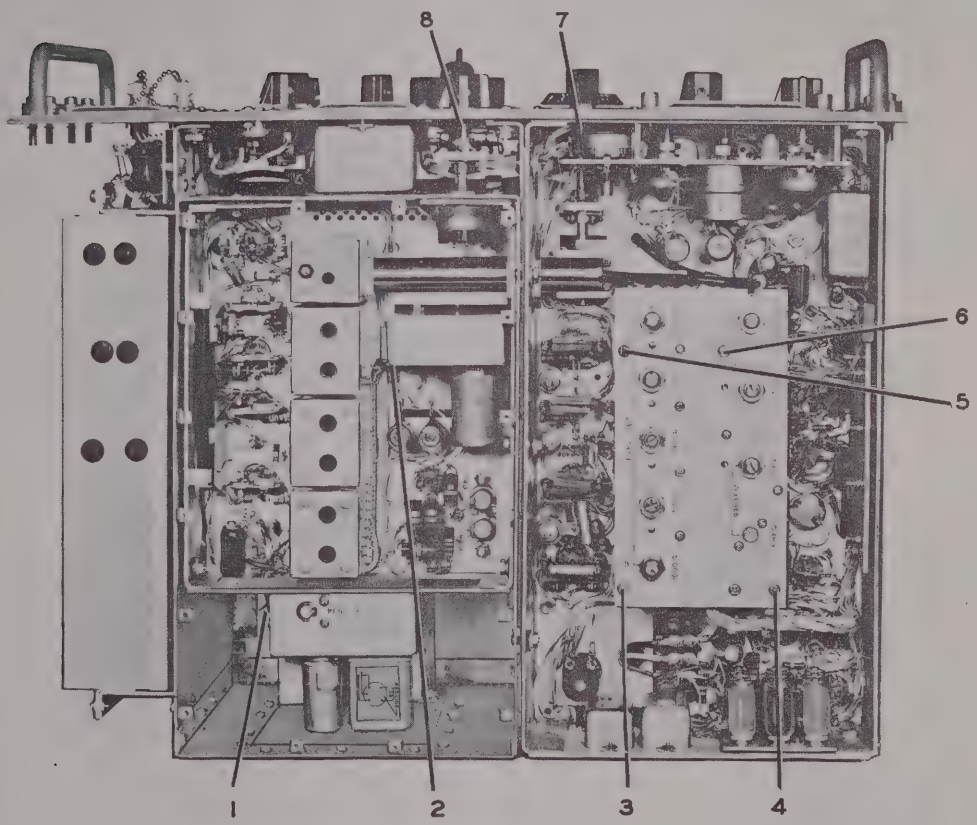
This function is confined to authorized overhaul activities only.

7-1. DISASSEMBLY.

7-2. REMOVAL OF COARSE FREQUENCY OSCILLATOR. Should it become necessary to remove the coarse frequency oscillator follow the procedure outlined below.

a. Remove the top, bottom and rear covers from the r-f section.

b. Unsolder the six leads, (1) figure 7-1, connected to the terminal strip on the side of the oscillator.



(1) Six coarse frequency oscillator leads
(2) Four fine frequency oscillator leads
(3)(4)(5)(6) Four Potentiometer Panel Mounting Screws
(7) MICROVOLTS control shaft bushing
(8) CARRIER SET control shaft bushing

Figure 7-1. Signal Generator SG-13/ARN, Bottom View

Label each lead as it is removed to insure proper replacement.

c. Remove the three nuts, (1) (2) (3) figure 7-2, which fasten the oscillator to the rear of the slug rack.

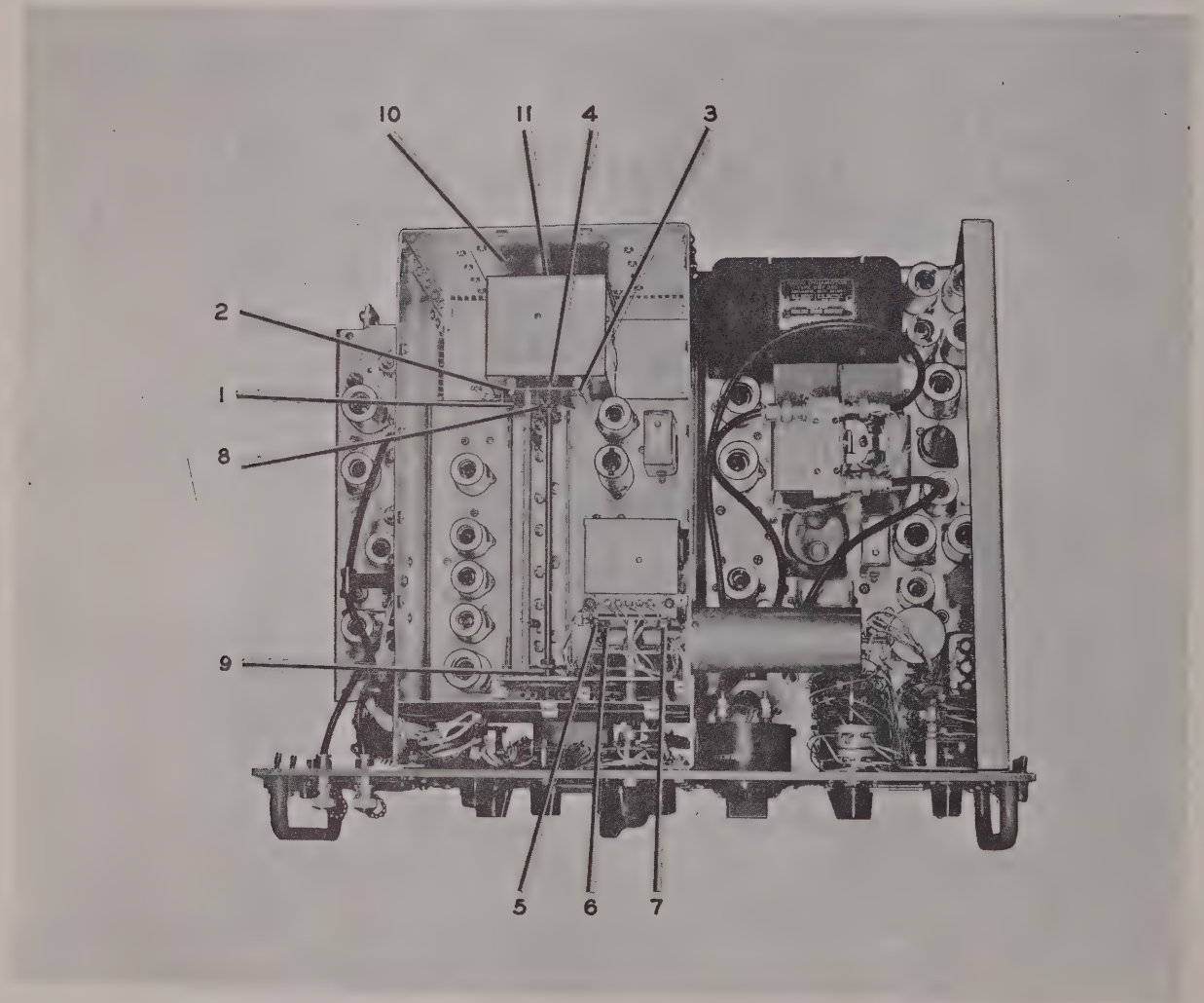
d. Slide the oscillator carefully off the slug rack shaft adapter, (4) figure 7-2, and out through the opening in the rear of the r-f shield.

e. Carefully note, or record by sketching, the orientation of the slots in the rotors of the two-section wafer switch in the oscillator. Also note and record the setting of the MEGACYCLES control on the front panel.

CAUTION

Never loosen the two set screws on the coarse frequency oscillator shaft adapter for any reason other than replacement of the shaft or adapter. If these screws should be loosened accidentally or for the purpose of replacing a damaged shaft or adapter follow the procedure in paragraph 7-6 to restore the original adjustment.

7-3. REASSEMBLY OF COARSE FREQUENCY OSCILLATOR. Unless it becomes necessary to move the switch rotors while the oscillator is disassembled the



(1)(2)(3) Nuts to remove in removal of Coarse Frequency Oscillator
(4) Coarse Frequency Oscillator Shaft Adapter
(5)(6)(7) Nuts to remove in removal of Fine Frequency Oscillator
(8)(9) Oil retaining felt washers
(10) Rear Access Plate
(11) Coarse Frequency Oscillator Cover

Figure 7-2. Signal Generator SG-13/ARN, Top View

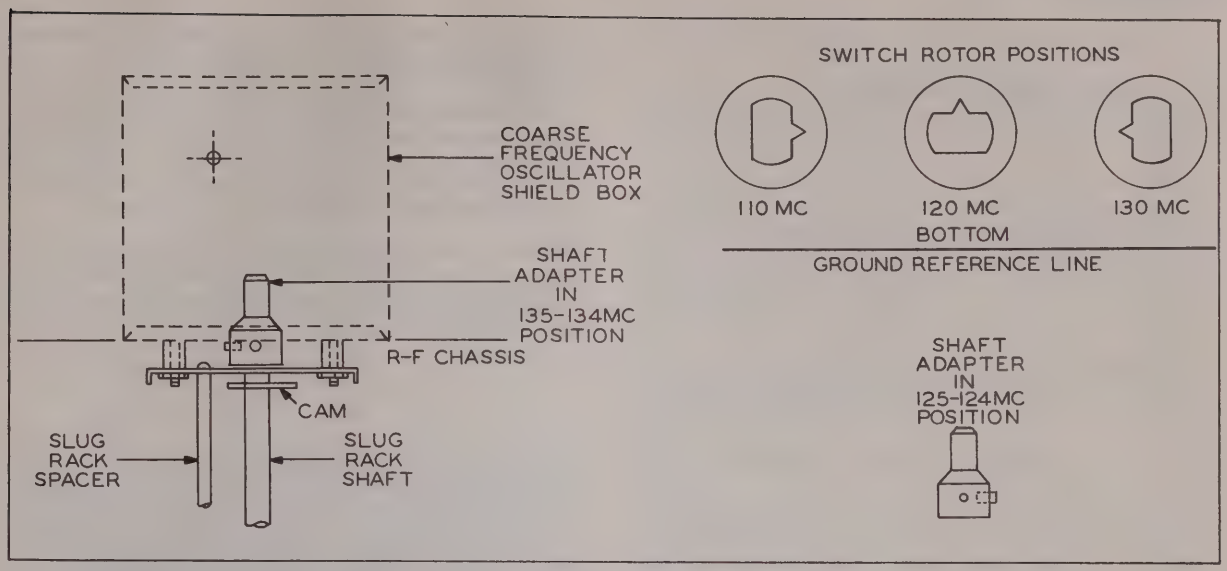


Figure 7-3. Coarse Frequency Oscillator Shaft Adapter and Switch Rotor Positions

oscillator can most easily be re-assembled to the slug rack by setting the MEGACYCLES control to the frequency noted in paragraph 7-2, step e, above and sliding the oscillator carefully back into place.

CAUTION

Unless care is exercised, the oscillator may be re-assembled to the slug rack with the switch rotors 180° from their correct position. Refer to figure 7-3 for relative positions of the slug rack adapter and switch rotors for several different frequencies.

CAUTION

There are two switches in the oscillator. Both switch rotors must be lined up properly before inserting shaft, otherwise damage to the second switch rotor will result.

7-4. COARSE FREQUENCY OSCILLATOR SWITCH ADJUSTMENT. If the two set screws on the coarse frequency oscillator shaft adapter ever become loosened and the synchronization lost, it will be necessary to follow the procedure below to restore the original synchronization.

7-5. TEST SETUP.

a. Remove rear access cover (10) and coarse frequency oscillator crystal cover (11)-Figure 7-2.

b. Pull out 9625.000 kc crystal, Y-1528 and attach an ohmmeter between the lower socket and ground as shown in Figure 7-5.

c. Set MEGACYCLES control to 135 MC.

7-6. PROCEDURE.

a. Loosen and turn the shaft adapter at the rear of the slug rack so that when viewed from the front of the signal generator one set screw is pointing straight out to the left and the other set screw is pointing straight up. This will closely approximate the 135 mc position.

b. Turn the adapter back and forth and note by the ohmmeter reading the approximate points at which the coarse frequency oscillator switch no longer makes

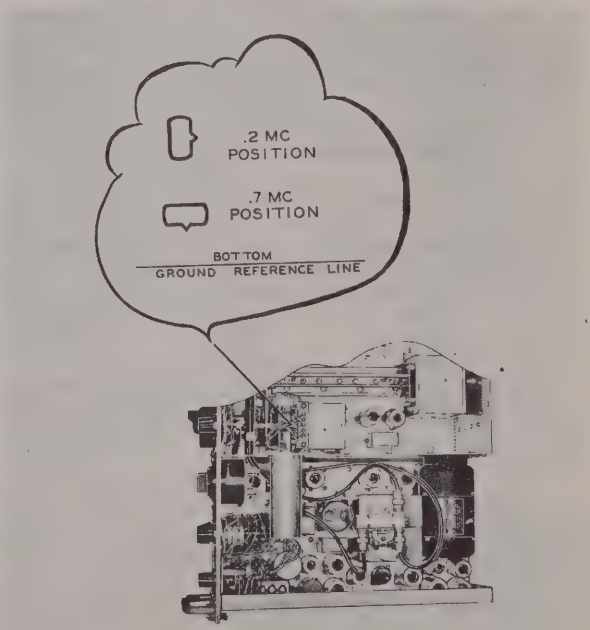


Figure 7-4. Fine Frequency Oscillator Switch Rotor Positions

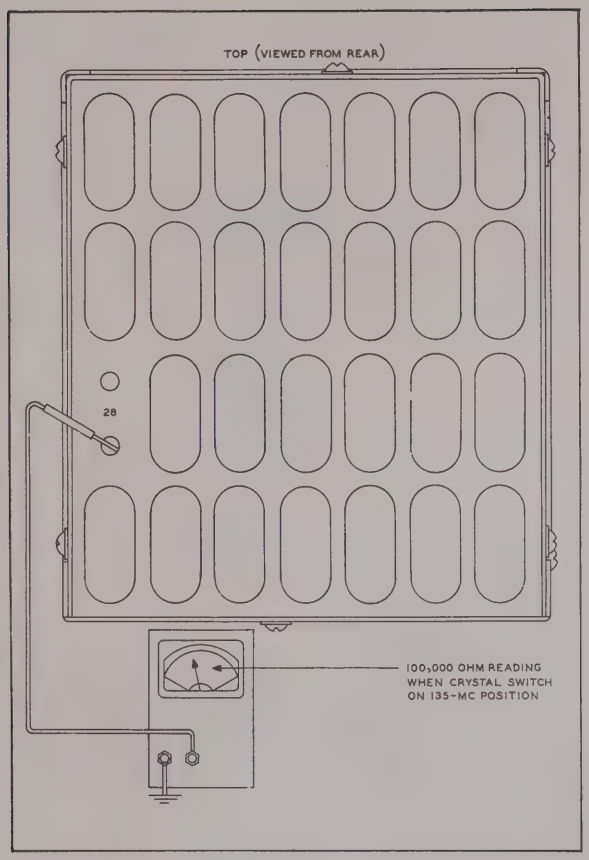


Figure 7-5. Test Connection - Coarse Frequency Oscillator Switch Adjustment

contact. These points will be evidenced by the ohmmeter reading rising from 100 K ohms to open circuit.

c. Set adapter midway between these two end points and tighten both set screws.

d. Replace crystal Y-1528 and the crystal cover. Connect power to the signal generator. Turn the MEGACYCLES control from 135 to 108 and back to 135 checking the reading of the CARRIER meter at each frequency setting to make certain that normal r-f output is obtained on all channels regardless of direction of approach.

e. If good switch contact is not obtained at all frequencies, re-set the MEGACYCLES control to 135 and repeat steps a through d until all channels operate satisfactorily.

7-7. REMOVAL OF FINE FREQUENCY OSCILLATOR. The fine frequency oscillator may be removed by following the procedure outlined below.

a. Remove the top and bottom covers on the r-f section.

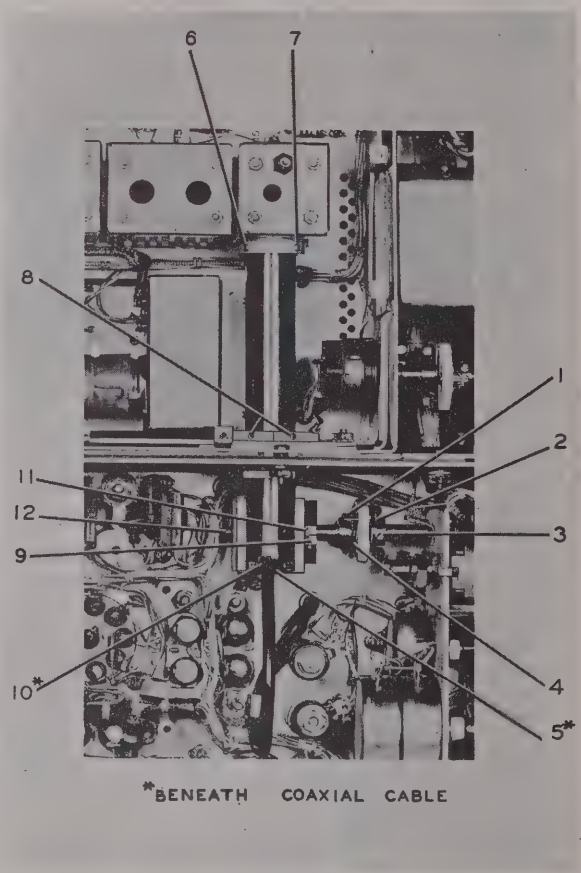
b. Remove the fine frequency oscillator tube, V-1501, and its shield.

c. Unsolder the four leads, (2) figure 7-1, connected to the terminal strip on the oscillator.

d. Remove the three nuts, (5) (6) (7) figure 7-2, that fasten the oscillator to the tuner frame.

e. Carefully slide the oscillator to the rear and off the shaft and then out the top of the r-f section.

f. Note, or record by sketching, the orientation of the slot in the rotor of the wafer switch in the oscillator. Also note or record the setting of the MEGACYCLES control on the front panel.



(1)(2)(3)(4) Set screws securing attenuator Shaft Coupler
(5) Attenuator plunger drive rack
(6)(7) Collar set screws
(8) Mounting bushing set screws
(9) Mechanical Stop
(10) Spur Gear
(11)(12) Spur Gear shaft bushings

Figure 7-6. Signal Generator SG-13/ARN R-f Attenuator Mounting

7-8. REASSEMBLY OF FINE FREQUENCY OSCILLATOR. Unless it becomes necessary to move the switch rotor while the oscillator is disassembled the oscillator can most easily be reassembled by setting the MEGACYCLES control to the frequency noted in paragraph 7-7, step f, above and sliding the oscillator carefully back into place.

CAUTION

Unless care is exercised, the oscillator may be re-assembled with the switch rotors 180° from their correct position. Refer to figure 7-4 for relative positions for .2 and .7-mc settings of the megacycles control.

7-9. REMOVAL OF ATTENUATOR. The attenuator may be removed by following the procedure outlined below.

a. Remove the four screws, (3) (4) (5) (6) figure 7-1, which fasten the large potentiometer panel to the underside of the audio chassis and lay the panel back so that no undue strain will be placed on the cable.

b. Loosen the four set screws, (1) (2) (3) (4) figure 7-6 on the attenuator shaft coupler and remove the coupler.

c. Grasp end of plunger rack (5) figure 7-6, and pull out at least two inches from the attenuator tube so that the pick-up loop will not protrude from the end of the tube and sustain possible damage during removal.

d. Remove the bottom cover of the r-f section.

e. Loosen the set screws, (6) (7) (8) figure 7-6, that secure the attenuator tube in the collar on the final r-f amplifier coil housing and the mounting bushing.

f. Slide the attenuator tube out of the collar and then carefully rotate the tube in the bushing, so that the shaft end of the assembly will clear components when withdrawn. The nuts securing two resistor stacks may have to be loosened to gain clearance. See figure 7-7.

g. Carefully slide attenuator out of the bushing. Disconnect attenuator cable from coaxial relay. Remove the UG-88/U connector from the cable.

7-10. REASSEMBLY OF ATTENUATOR.

a. Reverse the procedure in paragraph 7-9 above and slide the attenuator tube through the bushing and into the collar until the panel shaft and attenuator shaft are in exact alignment.

b. Upon completing the reassembly re-calibrate the attenuator as outlined in Section VIII, paragraph 8-4.

c. If the MICROVOLTS dial does not operate smoothly the panel shaft and attenuator shaft have not been accurately aligned. Loosen set screws on collar and align shafts properly, keeping the MICROVOLTS dial at some intermediate setting to prevent damage to the pickup loop while adjusting the attenuator tube position.

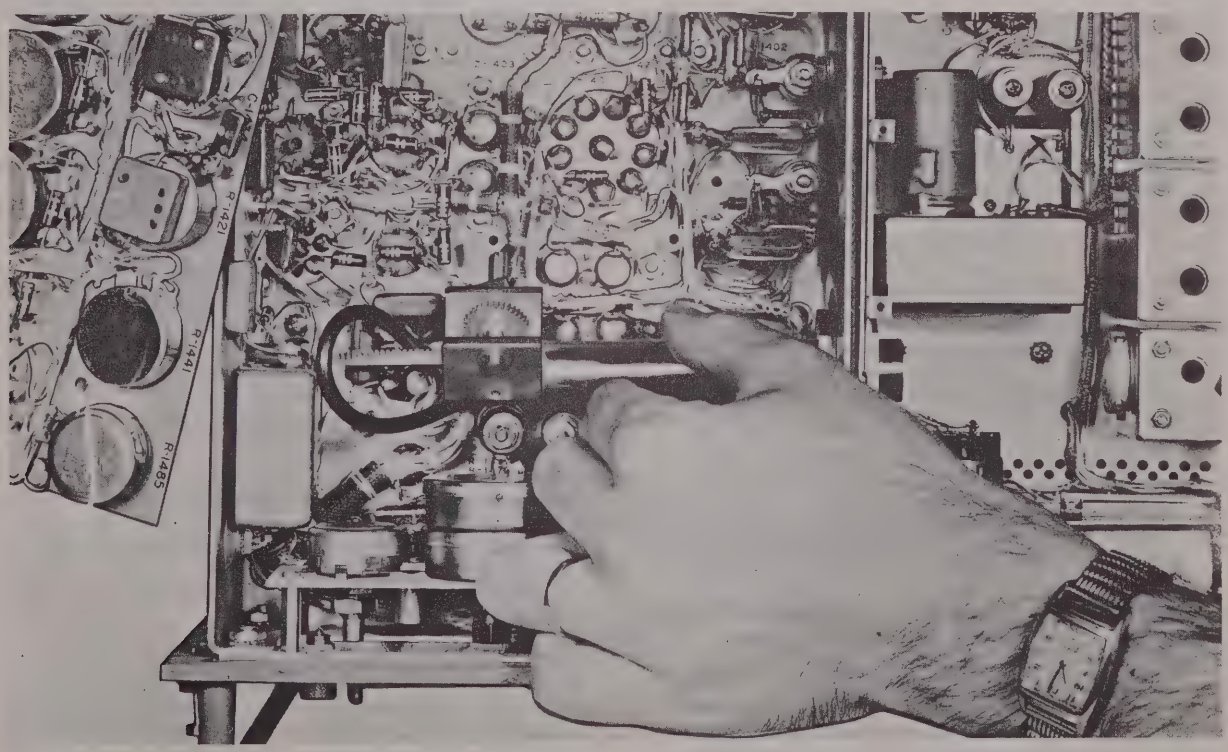


Figure 7-7. Signal Generator SG-13/ARN, R-F Attenuator Removal.

7-11. REMOVAL AND REPLACEMENT OF R-F TANK ASSEMBLIES, T-1501, T-1502, and Z-1501.

a. Unsolder and label the four leads entering the assembly.

b. Remove the two mounting screws accessible from the slug rack side.

c. Gently pull the assembly straight out, taking care not to damage the slugs as they are withdrawn from the assembly.

d. To gain access to parts, remove the four nuts securing the shield to the assembly. If necessary, remove the Bakelite plates.

e. When replacing the assembly, reverse the above procedure, again taking care not to damage the slugs as they are re-inserted into the coils.

7-12. REMOVAL OF R-F OUTPUT TANK, Z-1502.

a. Uncouple and slide back the attenuator until it is clear of the collar on Z-1502.

CAUTION

Do not attempt removal of Z-1502 until the attenuator is well clear of the collar.

b. Remove the two nuts mounting Z-1502 (accessible from the slug rack side).

c. Gently pull assembly straight out, taking care not to damage the slug as it is withdrawn from the coil.

7-13. DISASSEMBLY OF Z-1502.

a. Remove the four nuts securing the shield.

b. Remove top or bottom plates only if absolutely necessary.

CAUTION

Before loosening any of the five nuts on the top of the assembly, unsolder the bottom connection on trimmer capacitor C-1529 to prevent undue stress on the glass envelope and possible breakage.

7-14. REPLACEMENT OF Z-1502.

a. Reverse the procedure in paragraph 7-12, taking care not to damage the slug as it is inserted into the coil.

b. Couple the attenuator to the collar on the assembly.

NOTE

A bushing, which supports the attenuator tube, is adjusted at the factory for proper fit. Do not adjust or re-position this bushing unless the attenuator tube binds in the bushing due to improper alignment of the bushing with the collar on the Z-1502 assembly. Should this condition arise, re-position the bushing by loosening the hexagon nut which secures the bushing to the chassis. Correct the alignment and secure the bushing.

c. Recalibrate the attenuator as outlined in Section VIII, paragraph 8-4.

7-15. REPLACEMENT OF TUNING SLUGS. In the event that the powdered iron slugs become cracked or broken, replace the slugs using the following procedure.

a. Rotate the broken slug stud clockwise until the slug and stud drop down through the hole in the top of the tank assembly.

b. Insert a new slug through this same hole and, while holding the slug stud against the movable table with a small round rod, use a screwdriver to rotate the slug counterclockwise until the threads catch.

c. Check the slug table spring tension by selecting 135 mc (the slug table in extreme upward position) and checking to be certain that the rollers are tight against the cams. They must be tight enough so that vibration will not cause the slug table to move and as a result change the positions of the slugs in the coils.

7-16. DYNAMOTOR DISASSEMBLY AND ASSEMBLY PROCEDURE. The only disassembly that should be undertaken is the removal of brushes and bearings. To disassemble this part of the dynamotor proceed as follows.

a. Disconnect the three dynamotor leads from underside of chassis.

b. Remove four screws mounting dynamotor to chassis and lift dynamotor from chassis.

c. Remove end cover screw and pull off covers.

d. Remove fan by loosening Bristo set screws.

e. Remove screws holding the bearing retainer plates on the high and low voltage ends.

f. Remove two end bell assemblies after disconnecting the attached wires.

g. Remove ball bearing assemblies.

h. Do not disassemble the dynamotor any further.

i. To reassemble the unit, reverse the above procedure.

7-17. DYNAMOTOR COMMUTATOR DRESSING. Slight grooving of the commutators is not unusual after several hundred hours operation and may be considered as normal. If, however, it is desired to repolish the commutators, they may be polished with grade 000 or finer sandpaper.

CAUTION

Do not use emery cloth on the commutators. The abrasive is conductive and may cause short circuits in the armature by becoming imbedded in the slots between the bars.

Slight pitting can be removed by use of commutator dressing sticks of pumice grade by holding the end of the stick against the commutator face and exerting slight pressure while the dynamotor is running. This should be followed by canvas cloth polishing. If commutators are seriously worn or scored, they must be refinished by a properly equipped repair station.

7-18. DYNAMOTOR BRUSH SERVICING. Should the dynamotor brushes be binding in the brush holders, clean the brushes by wiping with a clean cloth dampened in unleaded gasoline. If this process does not correct the binding, thin the brushes down with No. 0000 sandpaper.

CAUTION

Do not allow the sandpaper to touch the contact surface of the brushes. Do not round off or chip off contact edges. Carefully remove abrasive and carbon dust.

Replace brushes that are cracked, damaged, or worn beyond the minimum length of one-fourth inch. If new brushes are installed, refer to paragraph 7-19 for brush setting procedure.

7-19. DYNAMOTOR BRUSH SEATING.

a. Place a strip of No. 000 sandpaper between the brush and the commutator, with the abrasive side facing the brush.

b. Apply only normal brush pressure. The sandpaper strip must be held snugly to the commutator so that it will have exactly the same curvature as the commutator. The strip should be drawn through in the direction of normal rotation.

CAUTION

Do not move the strip back and forth.

c. Relieve the brush pressure and repeat b. above as often as is required to form the brush face to seat 75% in the direction of rotation and 90 percent of the width of the brush. Do not round off or chip the contact surface edge. Any loose abrasive or carbon dust should be carefully removed.

d. Following the fitting, a light application of a special brush seating stone may be used to smooth out any grooves left by the abrasive.

NOTE

After installing new brushes, the dynamotor should be run in at normal load for a few hours to obtain the polished brush surface necessary for good commutation. Noisy and inefficient operation may be experienced until the brushes are properly worn in.

7-20. CLEANING DYNAMOTOR BALL BEARINGS.

CAUTION

Ball bearings should be lubricated as soon as possible after cleaning, inspection, and testing. Never spin a ball bearing which is not lubricated. Do not handle ball bearings with fingers. Doing so may cause corrosion. Use tweezers or gloves.

Wipe the bearing with a soft, clean, lint-free cloth. Place the bearings in a clean, corrosion-resistant wire basket, and suspend the basket in a container of filtered benzene, U.S. Army Specification No. 4-1016B. Agitate the basket to aid in flushing out the sludge. If necessary use a short bristled brush to remove the dirt. Place the bearings in a clean covered container until ready to use.

7-21. INSPECTION OF DYNAMOTOR BALL BEARINGS. Test each ball bearing by slowly rotating it. Bearings showing pronounced bumps or stickiness should be discarded and replaced. Inspect the bearings for cracks, rough or pitted surfaces, and damaged balls. The bearings should be a push fit on the armature shaft and hand tight in the housing.

7-22. LUBRICATION OF DYNAMOTOR BALL BEARINGS. Lubricate the bearings with AN-G-25 grease.

CAUTION

Do not jam the bearings full of grease. Only enough grease to fill one side of the ball race is necessary. Packing the bearings with grease will tend to cause the grease to run through the bearing seals and create excessive heat due to churning during operation.

SECTION VIII

ALIGNMENT, CALIBRATION, AND TESTS

8-1. ALIGNMENT.

8-2. INTRODUCTION. Signal Generator SG-13/ARN is carefully aligned and tested before it is shipped from the factory. The slugs and tuning capacitors are carefully adjusted at the factory and should never require more than a very slight adjustment.

CAUTION

Do not change slug positions or adjust variable capacitors except when making fine adjustments during actual alignment. Indiscriminate tuning will inevitably result in a completely misaligned instrument which will be difficult to repair.

If alignment is needed it is usually due to a change in capacitance which can be corrected by adjusting the tuning capacitor only. The tuning slugs will seldom need resetting and when they do the change necessary will be very small. The need for alignment will be indicated when it is not possible to adjust the needle on the meter to the red line when the METER switch is in the CAR position. This condition, however can be caused by faults other than misalignment such as bad tubes or a faulty meter or metering circuit. If a unit which has been operating satisfactorily suddenly drops off in performance, it is very unlikely that misalignment is the cause.

CAUTION

When misalignment is suspected as a cause of trouble check all other logical causes of trouble before undertaking realignment.

8-3. R-F SECTION ALIGNMENT. Alignment of the r-f section of Signal Generator SG-13/ARN is accomplished by following the procedure outlined below.

a. Connect Power Cable Assembly CX-1095/U or CX-1506/U to the 21VDC-29VDC connector on Signal Generator SG-13/ARN and to the source of power.

b. Turn the METER switch to the LINE position and turn the SET LINE to 21V switch until the meter reads 21 ±0.5V.

c. Turn METER switch to B+ position and read B+ voltage on meter. Reading should be 230 volts. Allow 10 minutes warm up.

d. With METER switch in CAR position, and CARRIER SET control fully counterclockwise adjust METER ZERO control until the meter reads zero.

e. Set MICROVOLTS dial to read 1K or lower.

f. Turn MEGACYCLES control to 135.5 mc and set the meter to the red line with the CARRIER SET control if possible.

g. Connect a d-c vacuum tube voltmeter to E-1508 (junction of R-1515 and R-1516).

h. Insert the iron end of the tuning wand into L-1503, L-1504, L-1510, L-1511, L-1505 and L-1506 and note any increase in d-c voltage at E-1508. Insert the iron end of the tuning wand into L-1508 and note any increase in output on the CAR meter. Insert the brass end of the tuning wand into the same coils and note any increase in E-1508 voltage or CAR meter reading. If a circuit is properly tuned inserting either end of the tuning wand will cause the output to drop. Note the results but do not make any adjustments. It will be noted that the tuning of the last two coils toward the front of the r-f chassis is much more critical than the tuning of the preceding stages.

i. Repeat step h at 108.5 megacycles.

j. Measure the d-c voltage at E-1508 as the MEGACYCLES control is rotated over the entire range. If the alignment is good the voltage will be at least -1.0 volts for any frequency. This is an overall check of all tuned circuits except the final circuit, Z-1502.

k. If the above steps indicate the need for alignment, continue with step l, below. The final tank circuit, Z-1502, is the one most likely to require alignment. In most cases a slight adjustment of C-1529 is all that is required.

l. Turn MEGACYCLES control to 135.5 and check for proper tuning of Z-1502 with the tuning wand. If inserting either end increases the output as read on the meter in the CAR position, tune C-1529 on the top of the final tank, Z-1502, for a maximum on the meter. See figure 8-1. The brass end of the tuning wand serves as an adjusting tool. Only a slight change in tuning capacitance should be necessary.

CAUTION

Indiscriminate tuning of the capacitor to its extreme maximum and minimum settings is unnecessary and may result in damage to the capacitor.

Recheck the tuning with the tuning wand.

m. Turn MEGACYCLES control to 108.5 and check for resonance with the tuning wand as in step h. If the circuit is not in resonance adjust the L-1508 slug in Z-1502. This adjustment is on the slug rack on top of the chassis. See figure 8-2.

n. Repeat steps l and m above until the circuit is in tune at both ends. Slugs are always adjusted at 108.5 mc and the trimmer capacitors at 135.5 mc. If the voltage on E-1508 is greater than -1.0 volts over the entire frequency range, further alignment is unnecessary. If further alignment is required, continue with step o below.

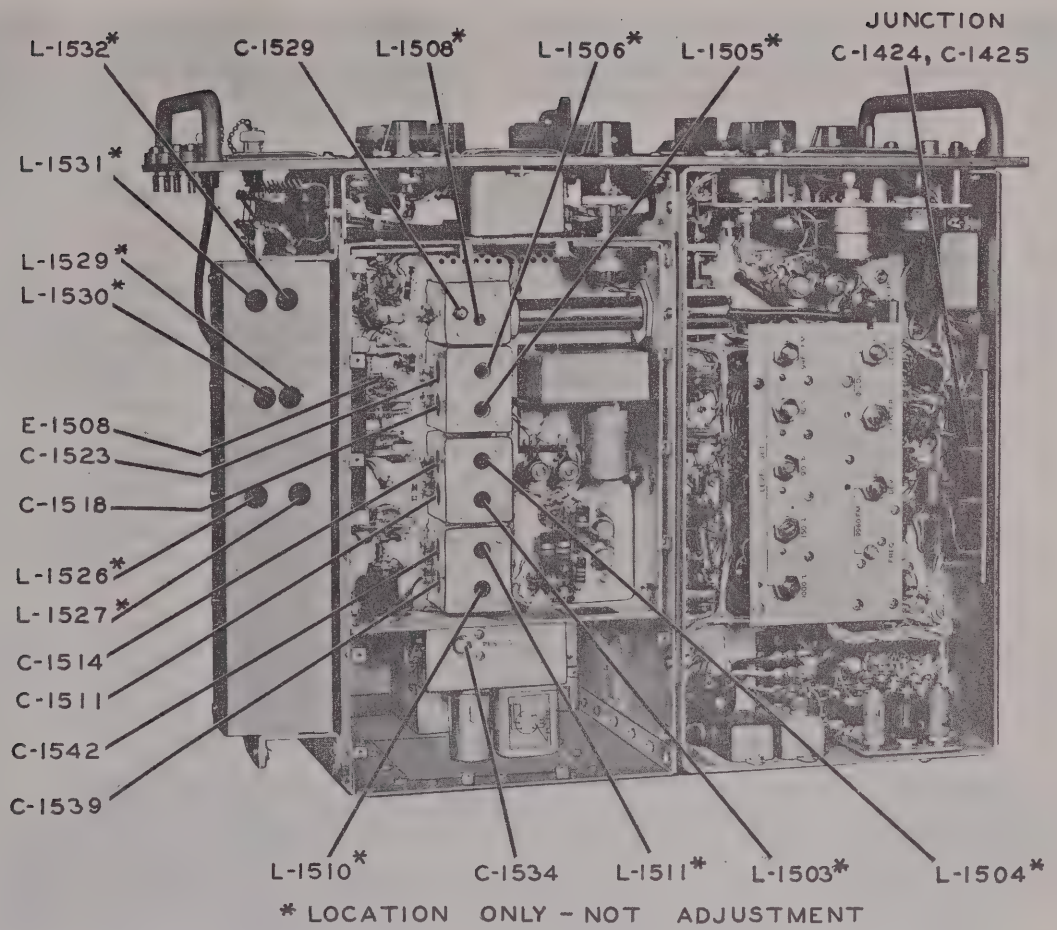


Figure 8-1. Signal Generator SG-13/ARN, Bottom Chassis Alignment Points

o. Connect a d-c vacuum tube voltmeter to E-1508 to measure the output of the quadrupler V-1505. Tune to 135.5 mc and check each coil in Z-1501 (L-1505 and L-1506) for resonance. Adjust the trimmers on the side of Z-1501 (C-1518 and C-1523) if necessary using the right angle screwdriver provided.

p. Tune to 108.5 mc and check for resonance. Adjust the L-1505 and L-1506 slugs in Z-1501 if necessary.

q. Repeat steps o and p until the tuned circuits are in resonance at both ends.

r. Adjust mixer coils in T-1502 (L-1503, L-1504) by tuning to 135.5 mc and inserting the iron end of the tuning wand in one coil until the circuit is detuned and the voltage on E-1508 falls to a low value. Adjust the trimmer on the other coil for maximum output. Repeat this procedure for the other mixer coil.

s. Tune to 108.5 mc and repeat procedure of step r.

t. Tune the coarse frequency oscillator output coils in T-1501 (L-1510, L-1511) in the same manner as the mixer. (Steps r and s above.)

u. The coarse frequency oscillator employs a frequency adjusting trimmer, C-1534, which is adjusted at the factory and should not require any further attention unless changes are made in the components or wiring in the grid circuit of V-1502. In this event, measure the frequency of the oscillator using each of the 28 frequencies. Make these measurements with a secondary frequency standard having an accuracy of ±0.001%. See table 6-2 for crystal frequencies. A small pick up loop inserted in the T-1501 coil nearest the coarse frequency oscillator (L-1510) will provide enough pick up to permit measurement of the 7375-9625 -kc signals. Rotate the MEGACYCLES control to each of the 28 positions and measure each of the 28 crystal frequencies. All should be accurate within ±0.0065%. If any of the crystal frequencies are found to be more than 0.0065% in error it will usually be found that all the other frequencies are in error in the same direction.

A slight adjustment of C-1534 at the bottom of the coarse frequency oscillator should shift all the crystal frequencies so that none will fall outside the ±0.0065% limits. If any crystal still falls outside these limits insert a new crystal to obtain required frequency.

8-4. R-F ATTENUATOR ALIGNMENT.

a. Place all covers on the r-f section and tighten all cover screws securely. This is necessary to prevent r-f leakage during alignment.

b. The r-f output is adjusted by comparing it with the output of a Signal Generator SG-1/ARN. Feed a 114.9 mc signal from Signal Generator SG-1/ARN into an ARN/14 navigation receiver with a d-c vacuum tube voltmeter connected to measure the receiver avc voltage. Use a 53-ohm 6-db pad in the cable connecting the receiver to the SG-1/ARN to keep the standing wave ratio low. See figure 8-5 for test connections.

c. Set Signal Generator SG-1/ARN MICROVOLTS dial to 500 microvolts and note avc voltage developed in the receiver.

d. Substitute Signal Generator SG-13/ARN for the SG-1/ARN using the same 6-db pad and adjust the MICROVOLTS dial until the same avc voltage reading is obtained. Adjust METER ZERO. The CARRIER SET control should be adjusted to the red line prior to this measurement. The MICROVOLTS dial should read 1000. If not, loosen the dial set screws with the Bristo wrench furnished and reset.

NOTE

The SG-1 microvolts dial is calibrated for use with a 6 db pad. The SG-13 microvolts dial is calibrated for a direct connection between NAV or GS output connectors and receiver input.

A 53-ohm 6db pad is used with the SG-13 output cable in this test only to insure proper termination of the SG-13 in case the receiver being used does not have exactly 53-ohms input impedance. For this reason, the SG-13 MICROVOLTS dial must be set to twice the reading of the SG-1 microvolts dial during this alignment procedure.

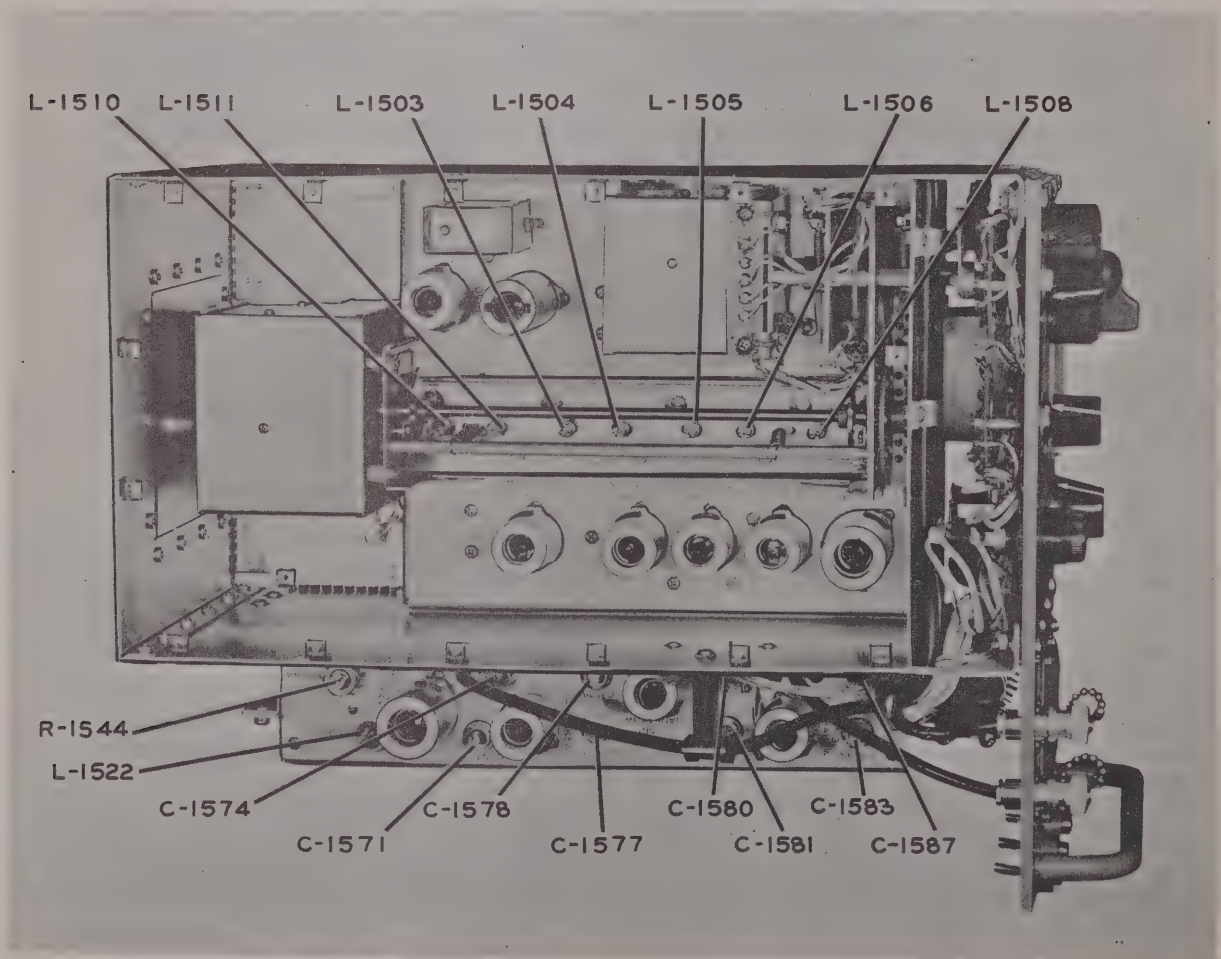


Figure 8-2. Signal Generator SG-13/ARN, Top R-f Chassis Alignment points.

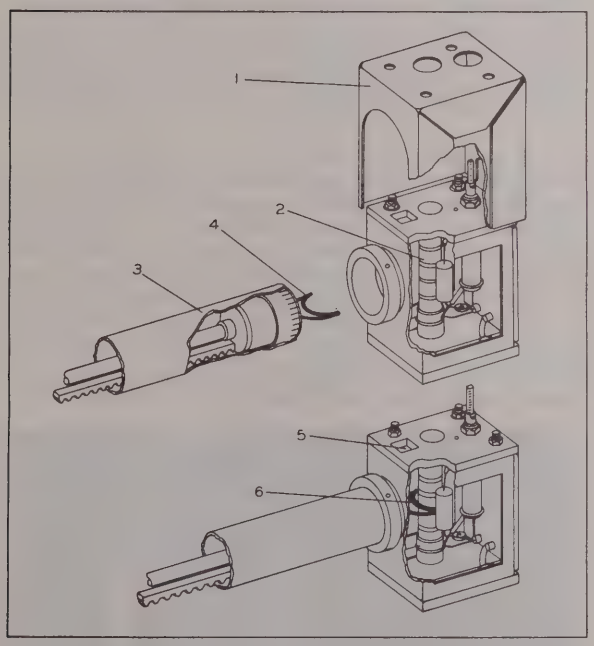
CAUTION

Take care to allow the signal from only one signal generator to get into the receiver while measuring the avc voltage. Adjust the signal generator not in use to some other frequency while making measurements.

e. Turn the SG-13/ARN MICROVOLTS dial to a maximum. This should give 200,000 microvolts which is comparable to a 100,000 microvolt setting on Signal Generator SG-1/ARN. If sufficient SG-13/ARN output cannot be obtained, reset the stop on the attenuator shaft. See (9) figure 7-5. With this stop set for a maximum output of 200,000 microvolts the attenuator dial will usually indicate that value with little error.

CAUTION

Use extreme care in turning the attenuator dial while the stop is being adjusted. If the dial is turned too far, the U-shaped pick-up loop in the attenuator may strike the final tank coil and be damaged. This is usually evidenced by the CAR meter reading dropping to zero at the highest setting of the MICROVOLTS dial.



1. Shield Can for Z-1502 Assembly
2. Final R-f Tank Coil, L-1508
3. Attenuator, removed from collar
4. Pick-up loop, r-f output
5. Inspection hole for viewing loop and coil clearance.
6. Point of normal 1/32 to 3/64 inch clearance, when MICROVOLTS dial set to maximum output.

Figure 8-3. R-f Output Coupling Assembly

8-5. The position of the pick up loop with respect to the coil at the maximum setting of the MICROVOLTS dial may be checked as follows, referring to figure 8-3.

a. Remove the bottom r-f shield cover.

b. Remove the four nuts and shake proof washers on the top of Z-1502 and pull off the shield can (1).

c. Shine a light through the square hole (5) on top of the housing and note the clearance (6) between the loop (4) and coil (2) with the MICROVOLTS dial set to its maximum output position. This clearance will normally be 1/32 to 3/64 inch. If the loop touches L-1508 at any point, insert a small screwdriver through the square hole and very carefully bend the loop until it centers properly. Repeat steps in paragraph 8-4 above.

8-6. UNIVERTER ALIGNMENT.

NOTE

Use a non metallic screw driver to adjust L-1522 and all variable capacitors located in the univerter.

a. Install the univerter cover and all r-f covers before alignment. Be sure the covers are properly seated and screws tightened securely.

b. Set NAV-GS switch on GS, MEGACYCLES dial on 332.0, and connect the GS output to the input jack of an ARN-18 Glide Slope receiver through a 53-ohm 6-db pad (UG-528/U). See figure 8-8. Adjust METER ZERO and set carrier level to the red line on the meter.

c. Connect a d-c vacuum tube voltmeter between L-1530 and ground. (L-1530 is accessible through the hole in the univerter cover as shown in figure 8-1. Make test connection by placing meter lead on any part of the turns in the coil.) Tune L-1522 by adjusting the slug for a peak d-c voltage. Record this voltage and then turn the slug-adjusting screw in a clockwise direction until the d-c voltage is 85% of the observed peak value.

d. Measure the receiver avc voltage with a d-c vacuum tube voltmeter and adjust the MICROVOLTS dial to a level just high enough to give a small avc voltage. In cases of extreme misalignment, it may be necessary to advance the setting of R-1544 in a clockwise direction to obtain an indication of avc voltage. Adjust C-1571 and C-1574 for maximum output as indicated by the receiver avc voltage.

e. Tune the overcoupled tuned circuits between the mixer and the first amplifier as follows. Short any two adjacent turns of L-1527 together by inserting a small metallic screw driver through the hole in the bottom cover of the univerter and tune C-1577 for maximum avc voltage. (If the avc voltage falls too low when the coil is shorted, increase the setting of the MICROVOLTS dial.) Then short L-1526 and tune C-1578. When tuning over coupled circuits, it is

always necessary to detune one side by shorting turns to tune the other side properly.

g. In the same manner, short L-1530 and tune C-1580, short L-1529 and tune C-1581, short L-1532 and tune C-1583, and short L-1531 and tune C-1587.

h. Check the univerter output to make sure it is uniform within ±15 percent over the frequency range 329.3 - 335.0 mc. This can be done by checking Signal Generator SG-13/ARN against an SG-2 signal generator. Set the SG-2 attenuator microvolts dial at 500 and feed a 332-mc signal into an ARN-18 Glide Slope receiver through a 53-ohm 6-db pad (Adapter UG-528/U). See figure 8-6. Note the receiver avc voltage. Substitute the SG-13/ARN for the SG-2, using the same frequency setting and 6-db pad with the MICROVOLTS dial set at 1000. (Use GS output connector.) Adjust R-1544 (figure 8-2) on the univerter to duplicate the avc reading noted above.

i. Check the univerter output as follows to insure that the response is sufficiently flat from 329.3 to 335.0 mc. Set SG-13/ARN MEGACYCLES control to 329.3 and MICROVOLTS dial to 1000. Feed the output into an ARN-18 receiver through Adapter UG-528/U and note the receiver avc reading. Substitute SG-2 for SG-13/ARN and duplicate the avc reading by adjusting the SG-2 output. The SG-2 output should be within ±15 percent of 500 microvolts. Make similar comparisons at 331.1, 332.0, 332.9 and 335.0 mc. If the 15 percent requirement is not met, readjust C-1583 and/or C-1587 slightly to correct any peaks or dips in the response and repeat the entire procedure outlined in paragraphs h. and i. above.

8-7. AUDIO SECTION ALIGNMENT. All audio adjustments must be made with the r-f covers on and all cover screws securely tightened. Set the SG-13/ARN MICROVOLTS dial at 1000 and the NAV-GS switch in the NAV position unless otherwise specified. Adjust for 21 volts line on the panel meter and allow 10 minutes warm up period before making any adjustments. Tighten locking nuts on controls as each adjustment is completed.

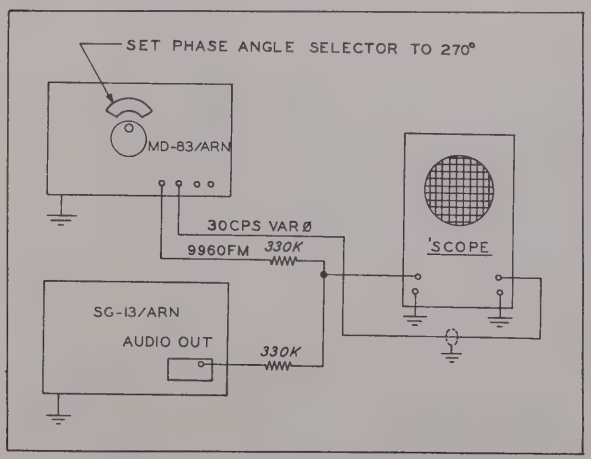


Figure 8-3A. Alternate Procedure, Frequency Adjustments

8-8. FREQUENCY ADJUSTMENT.

a. Connect the vertical input of an oscilloscope to the AUDIO OUT connector located behind access plate on the front panel and set AUDIO SELECTOR to 30 ~ VAR Ø. Adjust METER ZERO and set carrier to red line. Connect the 60 cps power line frequency or an accurate frequency standard to the horizontal input of the oscilloscope.

b. Set the 30 FREQUENCY control to exactly 30 cps by adjusting until the proper Lissajous pattern is obtained. This will be a double loop if the 60 cps power line frequency is used. Adjust until this double loop is stationary.

c. Rotate AUDIO SELECTOR to 9960 FM position and set DEV LEVEL control for zero deviation. Adjust the 9960 FM FREQ control to a frequency of 9960 cps as measured at the AUDIO OUT connector with an oscilloscope and accurately calibrated a-f oscillator using Lissajous patterns. This control is located on the potentiometer panel (figure 8-4). If the frequency is lower than 9960 cps at all settings of the 9960 FM FREQ control, remove the DA93 (white - orange) jumper wire used to connect C-1437 in parallel with C-1434. If the frequency is higher than 9960 cps at all settings of the 9960 FM FREQ control, connect a DA93 jumper wire to place C-1437 in parallel with C-1434. These capacitors are located on the underside of the potentiometer panel and accessible only when the panel is pulled back. See figure 8-4. Points A and B, figure 8-4, show the jumper connecting points. (Jumper not connected in this figure.)

d. If an accurately calibrated a-f oscillator is not available, the following alternate procedure may be used to set the 9960 cps frequency. Set AUDIO SELECTOR to the 9960 FM position and set DEV LEVEL control for zero deviation as before. Adjust the carrier set control approximately to the red line. Connect the AUDIO OUT connector to the vertical input of an oscilloscope through a 330K resistor (figure 8-3A). Connect the 30 cps variable phase connector of Modulator MD-83/ARN to the horizontal input of the oscilloscope. Adjust the PHASE ANGLE SELECTOR of

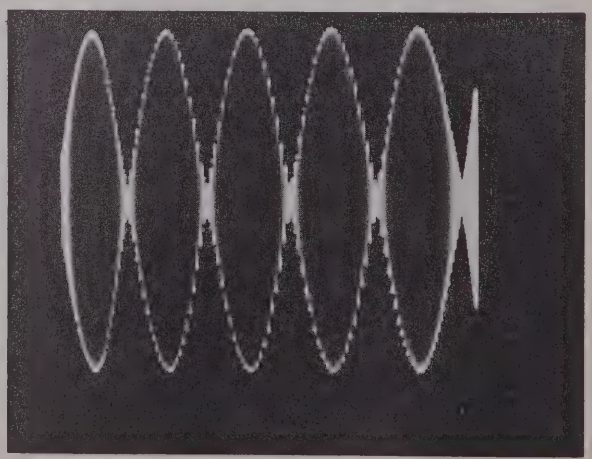


Figure 8-3B. Wave Form for 9960 cps Frequency

the MD-83/ARN to 270.0 degrees. Adjust the 9960 FM control to obtain the pattern shown in figure 8-3B. This pattern will be obtained only when the frequency is set exactly at 9960 cps. A slight adjustment of the PHASE ANGLE SELECTOR may be necessary to obtain proper alignment of the pattern.

e. Rotate AUDIO SELECTOR to 1000 ~ position and adjust 1000 ~ FREQUENCY control to obtain an oscillator frequency of 1000 ± 150 cps as measured with an oscilloscope and audio oscillator using Lissajous patterns.

8-9. MODULATION PERCENTAGES.

8-10. TEST EQUIPMENT REQUIRED. The modulation levels can be adjusted with the test setup shown in figure 8-5.

8-11. The modulation levels are stable and will seldom need resetting. A substitution method is used to set the audio levels on Signal Generator SG-13/ARN. A signal from Signal Generator SG-1/ARN and Modulator MD-83/ARN is fed into a VOR receiver. The avc and detector audio voltages of the receiver are noted. A similar signal from Signal Generator SG-13/ARN is then applied to the receiver and the levels adjusted to repeat the noted readings. In all the alignment procedures that follow a 53-ohm 6-db attenuator pad is used between the r-f cable from SG-13/ARN to the input connector of the navigation receiver. In all of the following procedures the r-f output cable is connected to the NAV OUTPUT connector and the NAV-GS switch must be in the NAV position.

8-12. 30 CPS MODULATION LEVEL.

a. Set up Signal Generator SG-1/ARN to read 500 microvolts at 110.1 mc and modulate it with 30 cps at 30% modulation as read on the SG-1/ARN modulation meter.

b. Connect this signal into the navigation receiver and read the 30 cps voltage developed at the receiver detector with an ac vacuum tube voltmeter. Also read the receiver avc voltage with a d-c vacuum tube voltmeter.

c. Substitute Signal Generator SG-13/ARN for Signal Generator SG-1/ARN and Modulator MD-83/ARN. Adjust the SET LINE TO 21V, METER ZERO and CARRIER SET controls. Adjust the MICROVOLTS dial until the same receiver avc voltage is obtained as in step b. above. The MICROVOLTS dial should read approximately 1000 microvolts.

d. With the AUDIO SELECTOR on the 30 ~ VAR ∅ position adjust the 30 ~ LEVEL SET control (figure 8-1) until the same 30 cps detector voltage is obtained as in step b. Lock the 30 ~ LEVEL SET control.

8-13. 9960 FM MODULATION LEVEL. With the AUDIO SELECTOR in the 9960 FM position set the 9960 FM LEVEL SET control to 30% modulation using the same procedure as described in paragraph 8-12, above.

8-14. 1000 CPS MODULATION LEVEL. With the AUDIO SELECTOR in the 1000 ∼ position adjust the 1000 LEVEL SET control to 30% modulation using the same procedure as described in paragraph 8-12, above.

8-15. 90 CPS AND 150 CPS MODULATION LEVELS AND TONE LOCALIZER CENTERING.

a. Set the AUDIO SELECTOR in the 90 ∼ position. Connect an ohmmeter scaled to read in the vicinity of 10,000 ohms between the center terminal of R-1418A and ground. (R-1418A is the front section of the dual LOC-GS potentiometer.) Rotate the LOC-GS control until the resistance reading is at a maximum. Loosen the knob of the LOC-GS control and position it on the shaft so that the knob points to the middle of the white center sector on the panel. Tighten the knob setscrews carefully with the knob set in this position.

b. With the AUDIO SELECTOR still in the 90 ∼ position and the LOC-GS control set to the middle of the white center sector, adjust the 90 LEVEL SET control to 20 percent modulation using the procedure of paragraph 8-12.

c. Connect the Ballantine Model 300 a-c Electronic Voltmeter to the AUDIO OUT connector and read the 90 cps voltage.

d. Without changing the setting of the LOC-GS control, rotate the AUDIO SELECTOR to 150 ∼ position and adjust the 150 LEVEL SET control to obtain the same voltage at the AUDIO OUT connector as read in step a, above, for 90 cps.

8-16. TONE LOCALIZER 6 DB TO 7.5 DB SECTOR ADJUSTMENTS. The zero db adjustments in paragraph 8-15 above must be made before the procedure below is undertaken.

a. Connect an a-c vacuum tube voltmeter to the AUDIO OUT connector on Signal Generator SG-13/ARN. Adjust SET LINE TO 21V, METER ZERO and CARRIER SET controls.

b. Loosen the two front panel screws that lock the two sectors on the LOC-GS control. Rotate the LOC-GS control to the right until the 90 cps voltage as read at the AUDIO OUT connector, with the AUDIO SELECTOR on the 90 ∼ position, is twice the 150 cps voltage as read at the same point with AUDIO SELECTOR on 150 ∼ position. When the setting of the LOC-GS control is obtained that gives a 2 to 1 ratio of voltages, move the right hand sector until the top engraved line on the sector is aligned with the center line on the knob. Hold the sector so it cannot move and turn the knob aside and tighten the screw to lock the sector in this position.

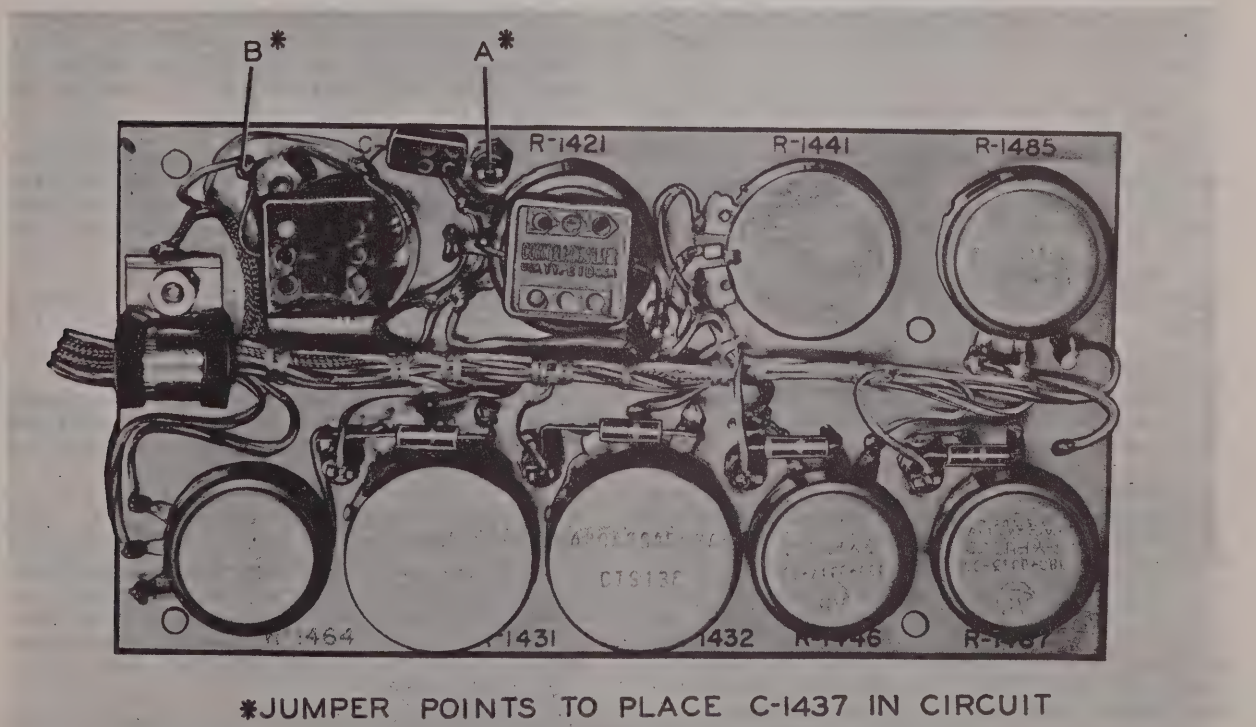


Figure 8-4. Potentiometer Panel Assembly

c. Use the same procedure to set the left hand sector. At this position the 150 cps voltage must be twice the 90 cps voltage for the proper setting of the sector. Use extreme care in making these sector adjustments. The glide slope and phase localizer operation depends upon these adjustments.

8-17. GLIDE SLOPE 0 DB AND 3 DB TO 3.75 DB ADJUSTMENTS.

The glide slope is automatically adjusted when the TONE LOC adjustment is made. It requires no additional setting of controls. These db adjustments may be checking at the AUDIO OUT connector by turning the AUDIO SELECTOR to GLIDE SLOPE and grounding the grid of the 150 CPS stage (V-1404, pin 2) while reading the 90 CPS voltage; then grounding the grid of the 90 CPS stage (V-1405, pin 2) while reading the 150 CPS voltage. The voltage ratios obtained with the LOC-GS control set at the top line of each sector will be 1.41 to 1 instead of 2 to 1. If not refer to last item in trouble chart, Section VI, paragraph 6-2.

8-18. 9960 FM DEVIATION RATIO.

a. Set up Signal Generator SG-1/ARN to read 500 microvolts at 114.9 mc and modulate it at 30% with the 9960 FM signal from Modulator MD-83/ARN.

b. Connect this signal into the navigation receiver and read the avc voltage with a d-c vacuum tube voltmeter. Also read the 30 cps voltage at the discriminator with a Ballantine Model 300 AC Electronic Voltmeter.

c. Substitute Signal Generator SG-13/ARN for Signal Generator SG-1/ARN. Adjust the SET LINE to 21V, METER ZERO, and CARRIER SET controls. With the AUDIO SELECTOR in the 9960 FM position adjust the MICROVOLTS dial until the same receiver avc voltage is obtained as in step b above.

d. Adjust the 9960 FM DEV control to obtain the same discriminator voltage as was read in step b above.

8-19. VOR ZERO ADJUSTMENT. The 30 ∼ FREQUENCY, 9960 FM FREQ, 9960 FM DEV, 30 LEVEL SET and 9960 FM LEVEL SET controls must be adjusted before beginning the following procedure.

a. This adjustment and the following VOR Tracking Adjustment require the use of Indicator ID-249A and an accurate zero reading microammeter (see figure 8-5) connected across the vertical (omni) crosspointer. The ARN-14 crosspointer output is designed for a 333-ohm load. The Weston Model 901 Microammeter has a 1000 ohm movement as do the ID-249A crosspointer movements. To obtain the necessary 333-ohm load in this test set-up, the glide slope crosspointer must be paralleled with the omni-crosspointer.

b. Set up Signal Generator SG-1/ARN to read 500 microvolts at 114.9 mc and modulate it at 30% with the VOR signal from Modulator MD-83/ARN. Connect output of Signal Generator SG-1/ARN to input of the navigation receiver.

c. Set the PHASE ANGLE SELECTOR on Modulator MD-83/ARN to 0 degrees and adjust the SET control on Indicator ID-249A until the Weston Model 901 Microammeter reads zero (centered). Do not change this setting of the SET control. Read the receiver AVC voltage with a d-c vacuum tube voltmeter.

d. Substitute Signal Generator SG-13/ARN for Signal Generator SG-1/ARN and Modulator MD-83/ARN. Set MEGACYCLES dial to 114.9 mc and adjust CARRIER SET control for red line indication.

e. Adjust the MICROVOLTS dial to duplicate the avc voltage read in step b above. Dial will read approximately 1000 microvolts.

f. With AUDIO SELECTOR in VOR position and the VOR switch in 0 degree position adjust VOR ZERO control until the microammeter is again centered. The TO-FROM indication will be TO.

8-20. VOR TRACKING ADJUSTMENT. The VOR tracking adjustment must be preceded by the VOR ZERO adjustment. Carry out adjustments given in paragraph 8-19 above before beginning procedures below.

a. Set up Signal Generator SG-1/ARN to read 500 microvolts at 114.9 mc and modulate it at 30% with the VOR signal from Modulator MD-83/ARN. Connect output of Signal Generator SG-1/ARN to input of the navigation receiver.

b. Set the PHASE ANGLE SELECTOR on Modulator MD-83/ARN to 90.0 degrees. Center the microammeter by setting the COURSE on ID-249A to approximately 90 degrees with the SET control. Do not change this SET control setting.

c. Substitute Signal Generator SG-13/ARN for Signal Generator SG-1/ARN and Modulator MD-83/ARN. Set MEGACYCLES dial to 114.9 mc and adjust CARRIER SET control for red line indication. Turn VOR switch to 90.0 degrees.

d. Adjust VOR TRACK control for exact centering of the microammeter. The TO-FROM indication will be TO.

e. Recheck the VOR ZERO adjustment as outlined in paragraph 8-19 and readjust if necessary. After both the VOR ZERO and VOR TRACK adjustments are made, lock both controls.

8-21. PHASE LOCALIZER ADJUSTMENT. The PHASE LOC CENTER and LEVEL controls are used to align the phase localizer for the previously determined positions of the localizer sectors and center setting of the control knob. The 30 cps modulation level and 30 LEVEL SET control must be adjusted prior to the ∅ LOC CENTER and LEVEL control adjustments.

a. Connect the Ballantine AC Electronic Voltmeter to the AUDIO OUT connector of Signal Generator SG-13/ARN. Set MEGACYCLES control to 110.1 mc, adjust SET LINE TO 21V, METER ZERO, and CARRIER SET controls.

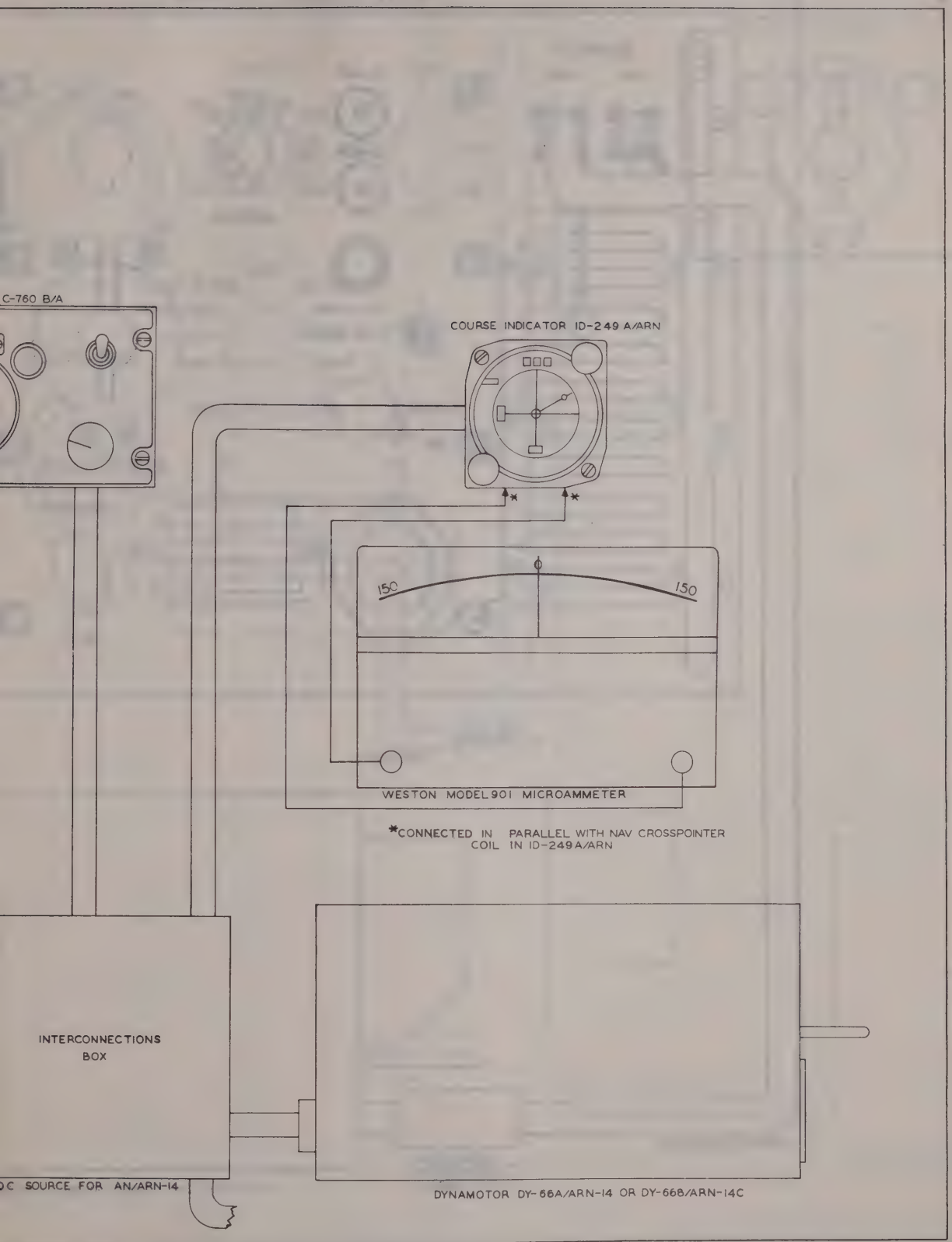


Figure 8-5. Test Setup - NAV Operation Check, Part 1

c. Use the same procedure to set the left hand sector. At this position the 150 cps voltage must be twice the 90 cps voltage for the proper setting of the sector. Use extreme care in making these sector adjustments. The glide slope and phase localizer operation depends upon these adjustments.

8-17. GLIDE SLOPE 0 DB AND 3 DB TO 3.75 DB ADJUSTMENTS.

The glide slope is automatically adjusted when the TONE LOC adjustment is made. It requires no additional setting of controls. These db adjustments may be checking at the AUDIO OUT connector by turning the AUDIO SELECTOR to GLIDE SLOPE and grounding the grid of the 150 CPS stage (V-1404, pin 2) while reading the 90 CPS voltage; then grounding the grid of the 90 CPS stage (V-1405, pin 2) while reading the 150 CPS voltage. The voltage ratios obtained with the LOC-GS control set at the top line of each sector will be 1.41 to 1 instead of 2 to 1. If not refer to last item in trouble chart, Section VI, paragraph 6-2.

8-18. 9960 FM DEVIATION RATIO.

a. Set up Signal Generator SG-1/ARN to read 500 microvolts at 114.9 mc and modulate it at 30% with the 9960 FM signal from Modulator MD-83/ARN.

b. Connect this signal into the navigation receiver and read the avc voltage with a d-c vacuum tube voltmeter. Also read the 30 cps voltage at the discriminator with a Ballantine Model 300 AC Electronic Voltmeter.

c. Substitute Signal Generator SG-13/ARN for Signal Generator SG-1/ARN. Adjust the SET LINE to 21V, METER ZERO, and CARRIER SET controls. With the AUDIO SELECTOR in the 9960 FM position adjust the MICROVOLTS dial until the same receiver avc voltage is obtained as in step b above.

d. Adjust the 9960 FM DEV control to obtain the same discriminator voltage as was read in step b above.

8-19. VOR ZERO ADJUSTMENT. The 30 ~ FREQUENCY, 9960 FM FREQ, 9960 FM DEV, 30 LEVEL SET and 9960 FM LEVEL SET controls must be adjusted before beginning the following procedure.

a. This adjustment and the following VOR Tracking Adjustment require the use of Indicator ID-249A and an accurate zero reading microammeter (see figure 8-5) connected across the vertical (omni) crosspointer. The ARN-14 crosspointer output is designed for a 333-ohm load. The Weston Model 901 Microammeter has a 1000 ohm movement as do the ID-249A crosspointer movements. To obtain the necessary 333-ohm load in this test set-up, the glide slope crosspointer must be paralleled with the omni-crosspointer.

b. Set up Signal Generator SG-1/ARN to read 500 microvolts at 114.9 mc and modulate it at 30% with the VOR signal from Modulator MD-83/ARN. Connect output of Signal Generator SG-1/ARN to input of the navigation receiver.

c. Set the PHASE ANGLE SELECTOR on Modulator MD-83/ARN to 0 degrees and adjust the SET control on Indicator ID-249A until the Weston Model 901 Microammeter reads zero (centered). Do not change this setting of the SET control. Read the receiver AVC voltage with a d-c vacuum tube voltmeter.

d. Substitute Signal Generator SG-13/ARN for Signal Generator SG-1/ARN and Modulator MD-83/ARN. Set MEGACYCLES dial to 114.9 mc and adjust CARRIER SET control for red line indication.

e. Adjust the MICROVOLTS dial to duplicate the avc voltage read in step b above. Dial will read approximately 1000 microvolts.

f. With AUDIO SELECTOR in VOR position and the VOR switch in 0 degree position adjust VOR ZERO control until the microammeter is again centered. The TO-FROM indication will be TO.

8-20. VOR TRACKING ADJUSTMENT. The VOR tracking adjustment must be preceded by the VOR ZERO adjustment. Carry out adjustments given in paragraph 8-19 above before beginning procedures below.

a. Set up Signal Generator SG-1/ARN to read 500 microvolts at 114.9 mc and modulate it at 30% with the VOR signal from Modulator MD-83/ARN. Connect output of Signal Generator SG-1/ARN to input of the navigation receiver.

b. Set the PHASE ANGLE SELECTOR on Modulator MD-83/ARN to 90.0 degrees. Center the microammeter by setting the COURSE on ID-249A to approximately 90 degrees with the SET control. Do not change this SET control setting.

c. Substitute Signal Generator SG-13/ARN for Signal Generator SG-1/ARN and Modulator MD-83/ARN. Set MEGACYCLES dial to 114.9 mc and adjust CARRIER SET control for red line indication. Turn VOR switch to 90.0 degrees.

d. Adjust VOR TRACK control for exact centering of the microammeter. The TO-FROM indication will be TO.

e. Recheck the VOR ZERO adjustment as outlined in paragraph 8-19 and readjust if necessary. After both the VOR ZERO and VOR TRACK adjustments are made, lock both controls.

8-21. PHASE LOCALIZER ADJUSTMENT. The PHASE LOC CENTER and LEVEL controls are used to align the phase localizer for the previously determined positions of the localizer sectors and center setting of the control knob. The 30 cps modulation level and 30 LEVEL SET control must be adjusted prior to the ϕ LOC CENTER and LEVEL control adjustments.

a. Connect the Ballantine AC Electronic Voltmeter to the AUDIO OUT connector of Signal Generator SG-13/ARN. Set MEGACYCLES control to 110.1 mc, adjust SET LINE TO 21V, METER ZERO, and CARRIER SET controls.

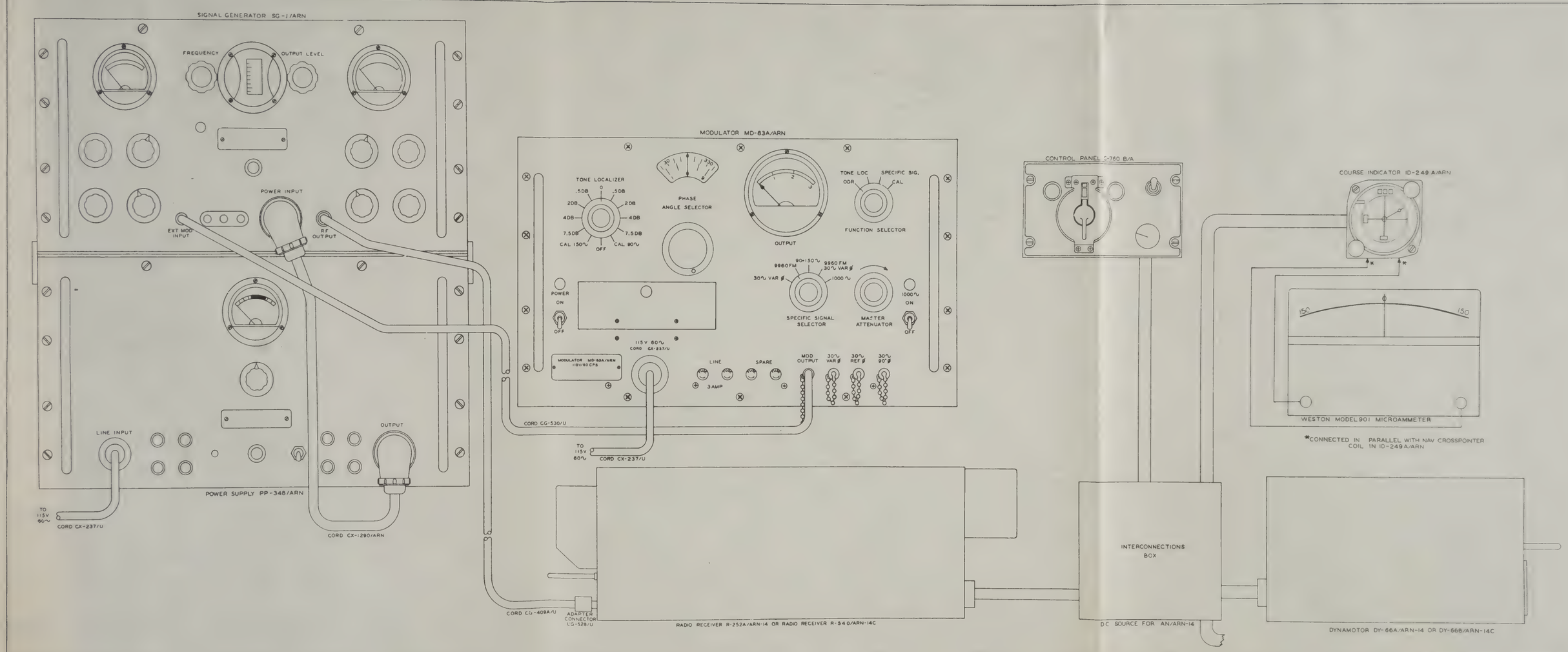
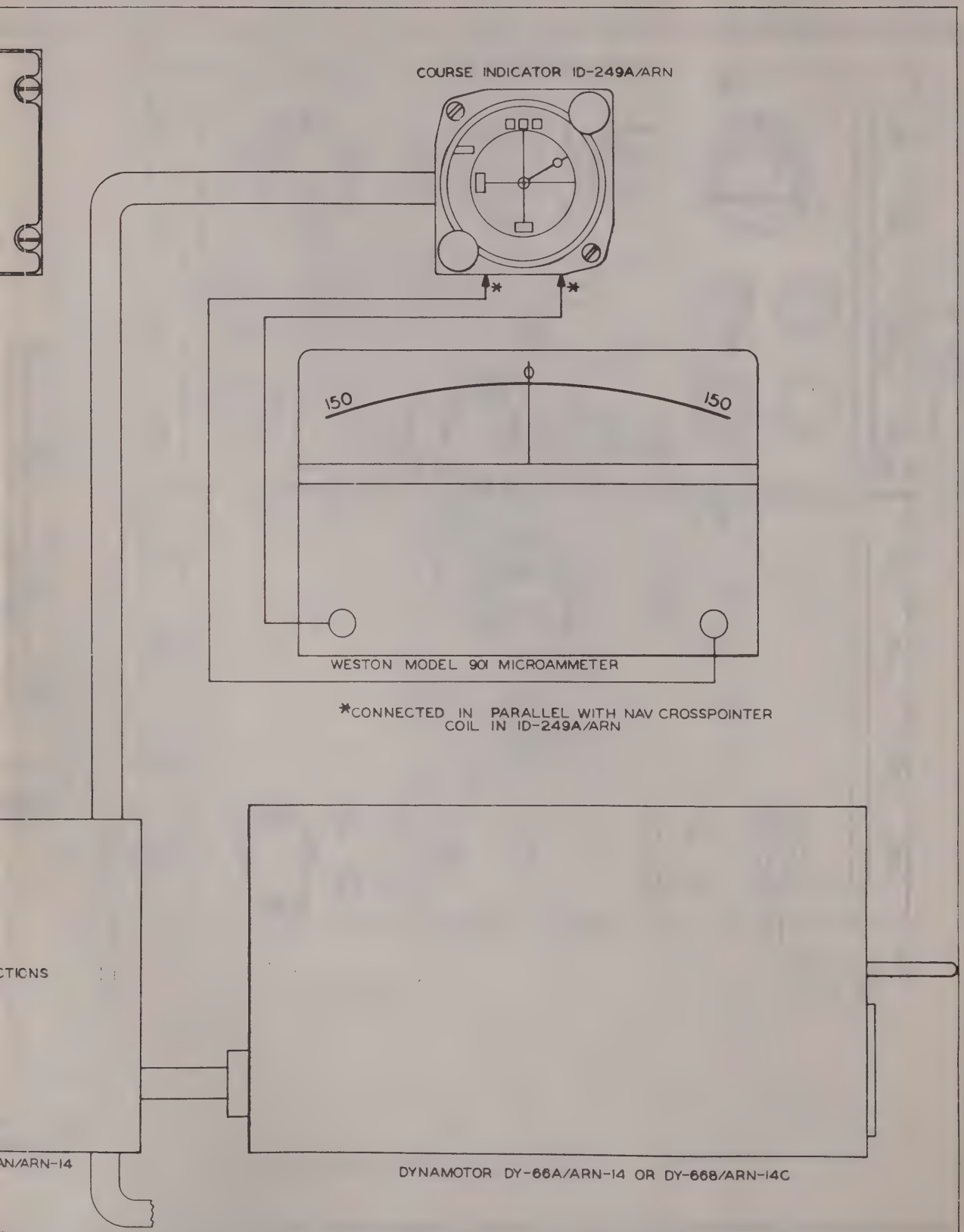
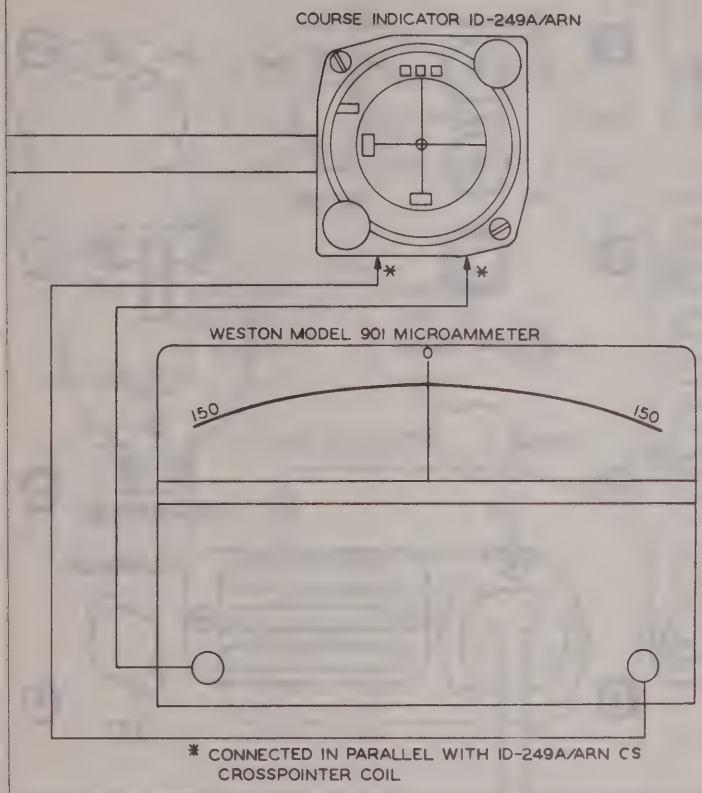


Figure 8-5. Test Setup - NAV Operation Check, Part 1


COURSE INDICATOR ID-249A/ARN
150
150
WESTON MODEL 901 MICROAMMETER
*CONNECTED IN PARALLEL WITH NAV CROSSPOINTER COIL IN ID-249A/ARN
CTIONS
AN/ARN-14
DYNAMOTOR DY-66A/ARN-14 OR DY-668/ARN-14C



2/ARN-18

Test Setup - GS Operation Check, Part 1

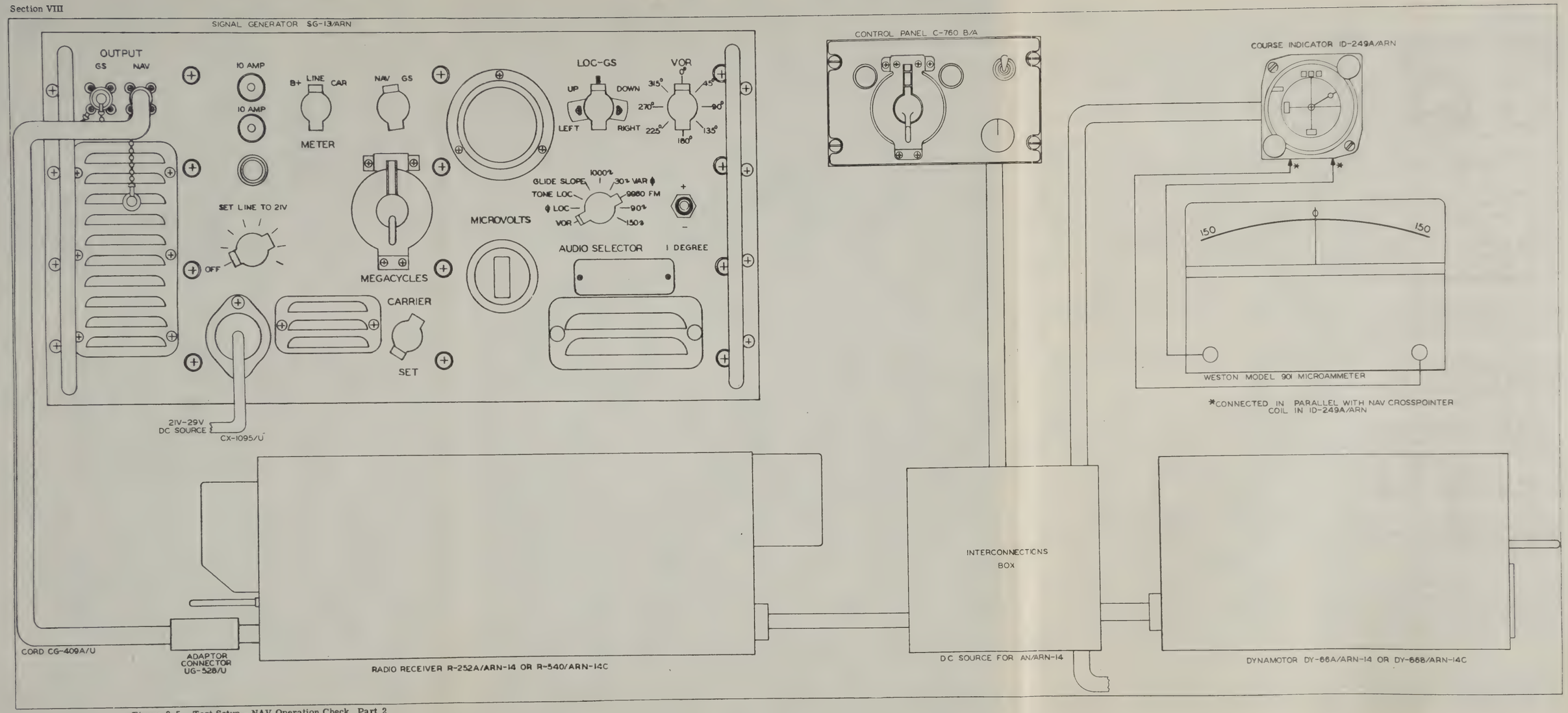


Figure 8-5. Test Setup - NAV Operation Check, Part 2

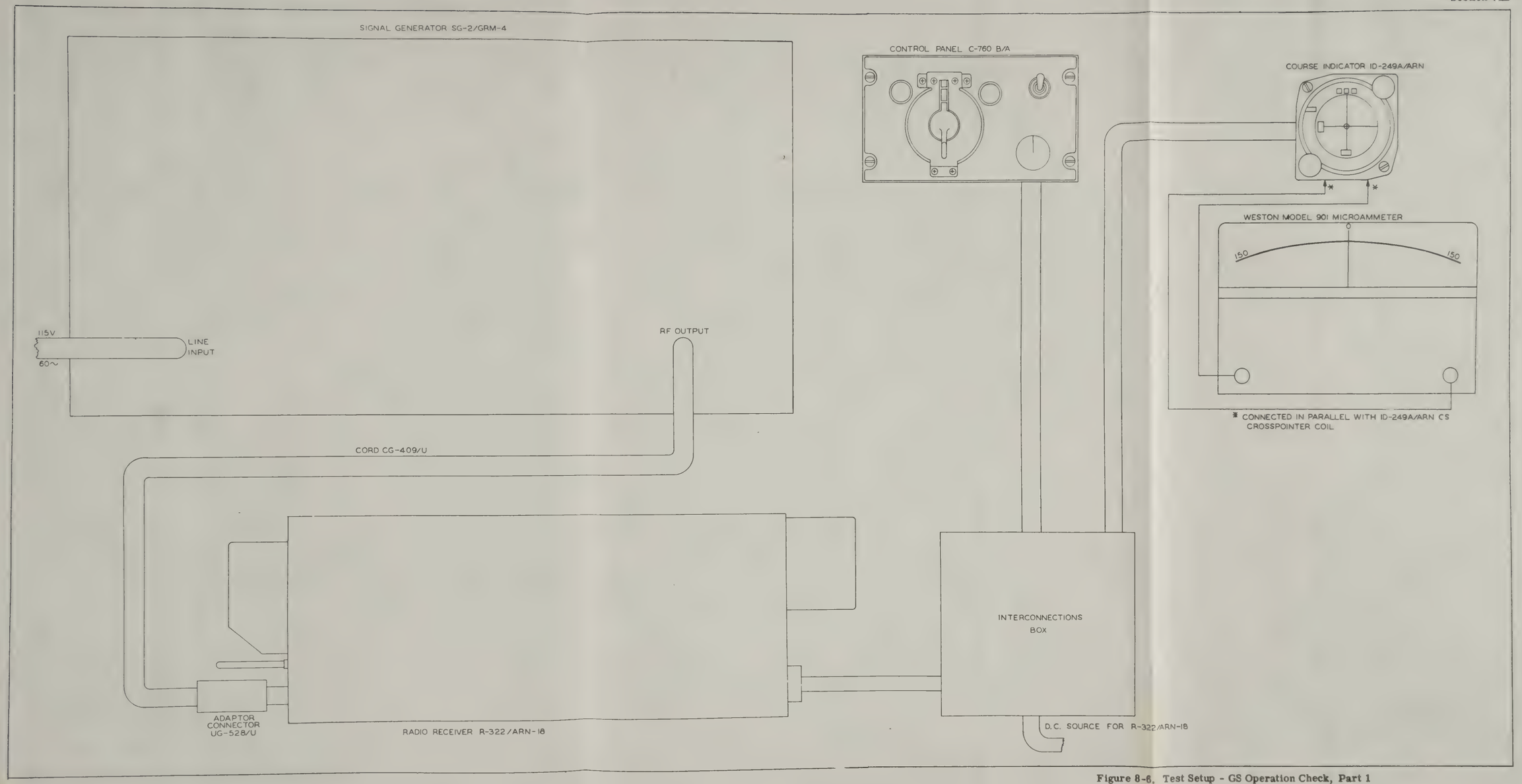
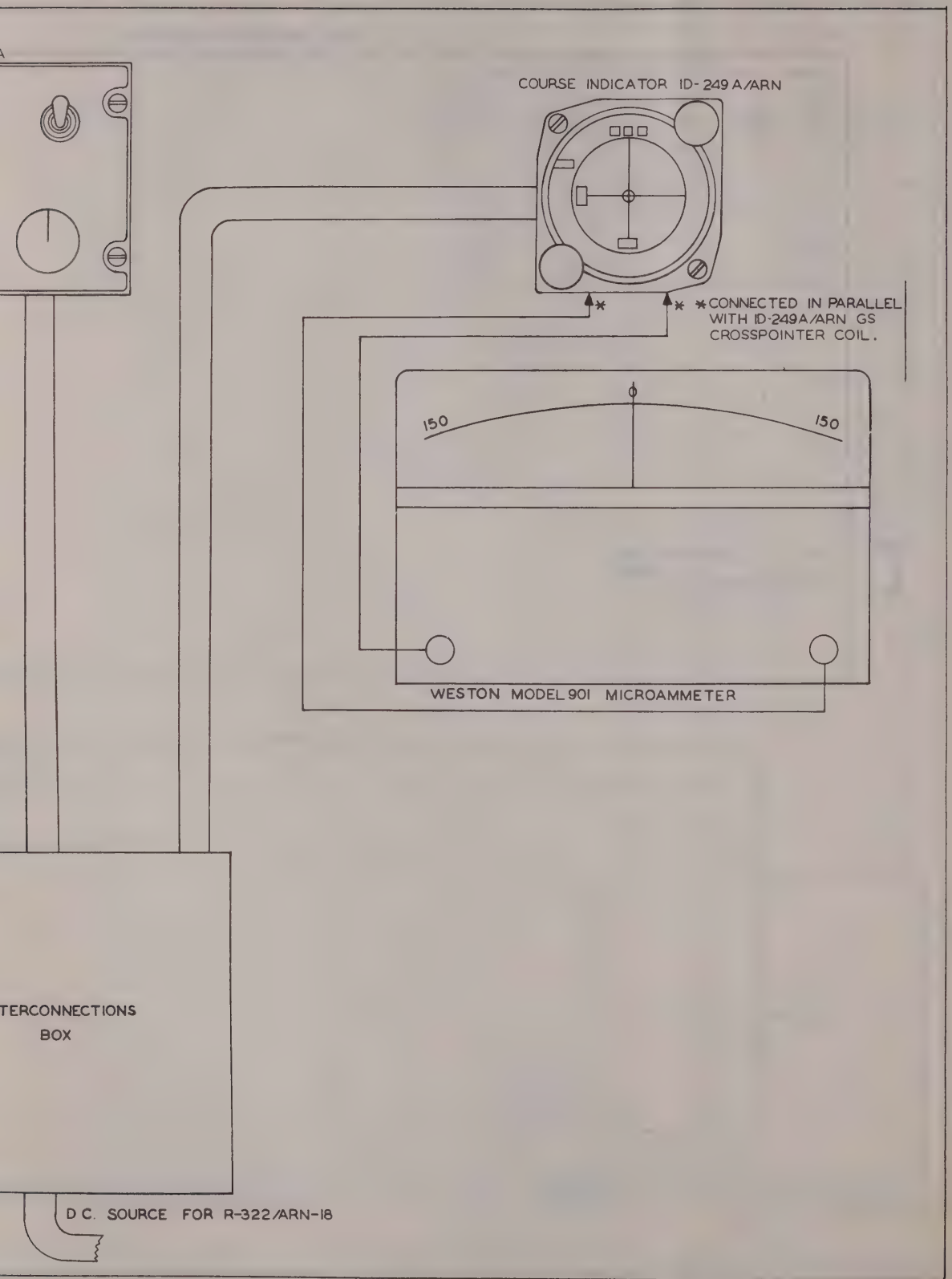


Figure 8-6. Test Setup - GS Operation Check, Part 1


COURSE INDICATOR ID-249A/ARN
* *CONNECTED IN PARALLEL WITH ID-249A/ARN GS CROSSPOINTER COIL.
150
150
WESTON MODEL 901 MICROAMMETER
TERCONNECTIONS BOX
D C. SOURCE FOR R-322/ARN-18

b. Turn AUDIO SELECTOR to the 30 ~ VAR ∅ position and note the 30 cps voltage obtained at the AUDIO OUT connector. It should be approximately 0.65 volts.

c. Turn AUDIO SELECTOR to ∅ LOC position and ground the junction of C-1424 and C-1425 to render the 9960 FM oscillator inoperative. See figure 8-1.

d. Turn the LOC-GS control to the right and set the knob center line on the top engraved line of the right hand sector.

e. Set the ∅ LOC LEVEL control to obtain a voltage reading on the Ballantine voltmeter which is 38% of the voltage noted above in the 30 ~ VAR ∅ position. With the 9960 FM oscillator still inoperative set the LOC-GS control to the middle of the white center sector engraved on the panel and adjust the ∅ LOC CENTER control for a null reading of the meter. Recheck the ∅ LOC LEVEL control and readjust if necessary. Turning the LOC-GS control to the top engraved line of left sector, a voltage reading will be obtained which is the same as the top line of the right hand sector if the two sectors have been very carefully adjusted as instructed in paragraph 8-16. Lock the controls.

8-22. Table of Typical AC Voltage Measurements.

Measurements made with a Ballantine electronic voltmeter model 300.

Conditions of measurement: Line voltage set to 21V. D.C., NAV-GS switch on NAV, MEGACYCLES control on 114.9, VOR switch on 0°, LOC-GS control set to center position, METER switch on CAR, SET CARRIER adjusted to the red line.

Component	Terminal Number	AUDIO SELECTOR Setting				
		30 VAR	90	150	1000	9960 FM
V1401	6	14				
V1402	1	14				
V1402	6	14				
V1403	2	1.5				
V1403	7	1.5				
V1403	1	27.0				
V1403	6	27.0				
T1401	4	6.3				
T1401	7	6.3				
T1401	10	3.0				
T1401	8	3.0				
V1401	3	4.5				
V1407	7	0.27				
Z1402	1		0.25			
Z1404	1			0.25		
V1407	3				0.43	0.57
V1408	1					3.0
V1408	7	0.11	0.071	0.071	0.12	0.16
V1507	1	0.69	0.46	0.46	0.75	0.86
V1508	7	14.8	10	10	15.5	15.8
V1508	2	13.2	9.1	9.1	14.2	14.9
V1506	6	6.9	4.7	4.7	7.3	7.4
J1408		0.59	0.4	0.4	0.64	0.68

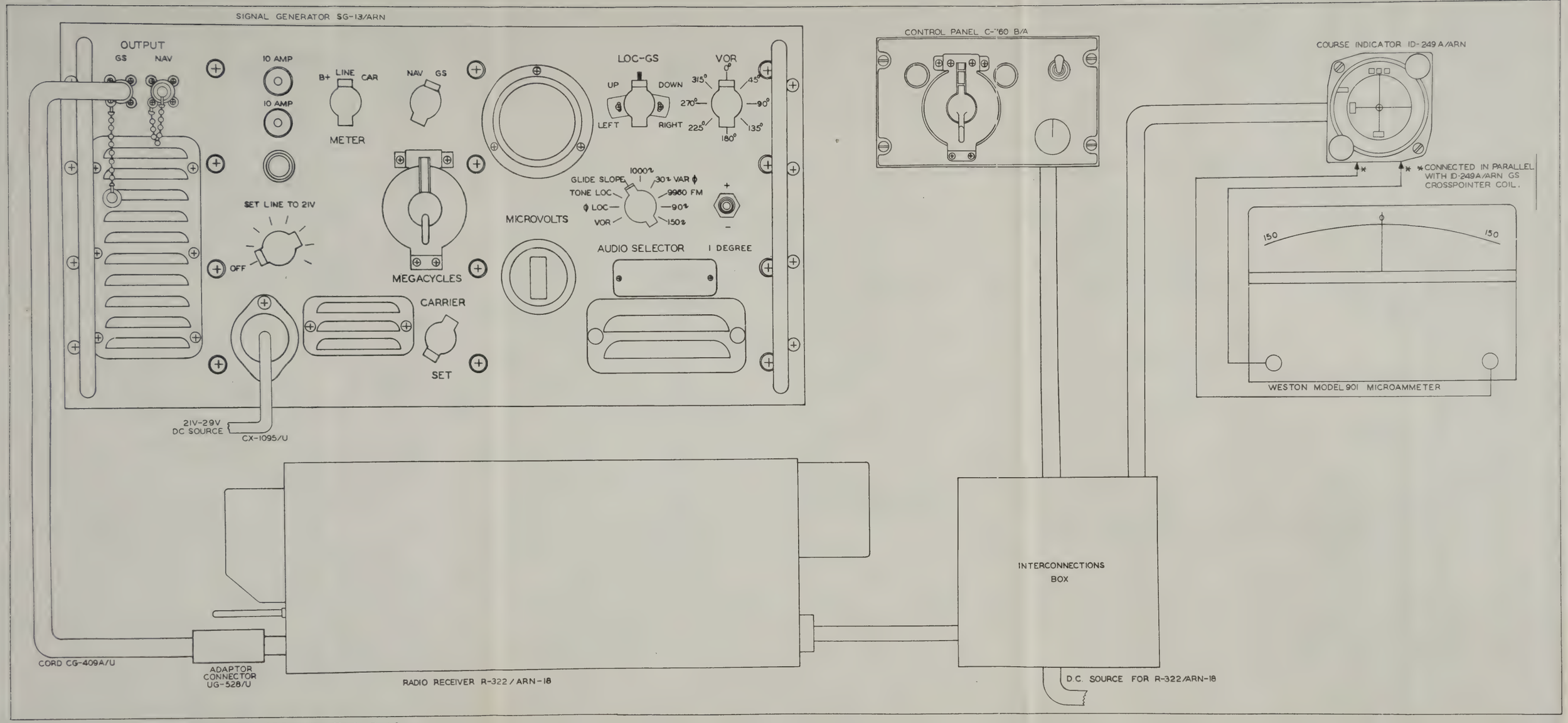
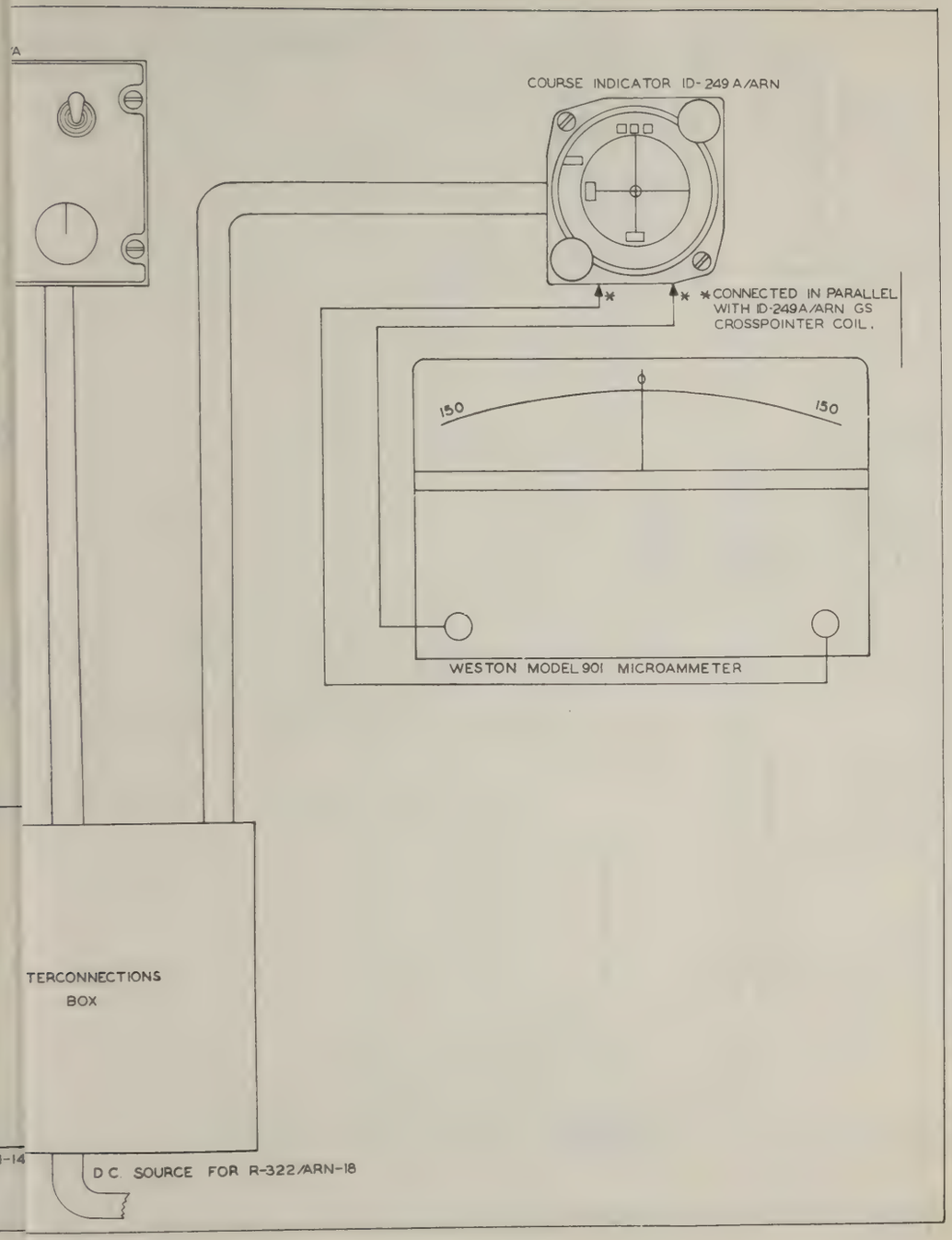


Figure 8-6. Test Setup - GS Operation Check, Part 2



b. Turn AUDIO SELECTOR to the 30 ∼ VAR ∅ position and note the 30 cps voltage obtained at the AUDIO OUT connector. It should be approximately 0.65 volts.

c. Turn AUDIO SELECTOR to ∅ LOC position and ground the junction of C-1424 and C-1425 to render the 9960 FM oscillator inoperative. See figure 8-1.

d. Turn the LOC-GS control to the right and set the knob center line on the top engraved line of the right hand sector.

e. Set the ∅ LOC LEVEL control to obtain a voltage reading on the Ballantine voltmeter which is 38% of the voltage noted above in the 30 ∼ VAR ∅ position. With the 9960 FM oscillator still inoperative set the LOC-GS control to the middle of the white center sector engraved on the panel and adjust the ∅ LOC CENTER control for a null reading of the meter. Recheck the ∅ LOC LEVEL control and readjust if necessary. Turning the LOC-GS control to the top engraved line of left sector, a voltage reading will be obtained which is the same as the top line of the right hand sector if the two sectors have been very carefully adjusted as instructed in paragraph 8-16. Lock the controls.

8-22. Table of Typical AC Voltage Measurements.

Measurements made with a Ballantine electronic voltmeter model 300.

Conditions of measurement: Line voltage set to 21V. D.C., NAV-GS switch on NAV, MEGACYCLES control on 114.9, VOR switch on 0°, LOC-GS control set to center position, METER switch on CAR, SET CARRIER adjusted to the red line.

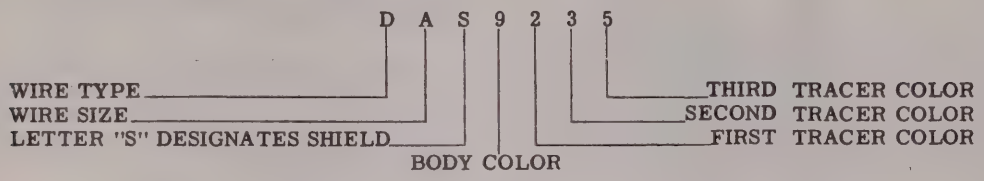
Component	Terminal Number	AUDIO SELECTOR Setting				
		30 VAR	90	150	1000	9960 FM
V1401	6	14				
V1402	1	14				
V1402	6	14				
V1403	2	1.5				
V1403	7	1.5				
V1403	1	27.0				
V1403	6	27.0				
T1401	4	6.3				
T1401	7	6.3				
T1401	10	3.0				
T1401	8	3.0				
V1401	3	4.5				
V1407	7	0.27				
Z1402	1		0.25			
Z1404	1			0.25		
V1407	3				0.43	0.57
V1408	1					3.0
V1408	7	0.11	0.071	0.071	0.12	0.16
V1507	1	0.69	0.46	0.46	0.75	0.86
V1508	7	14.8	10	10	15.5	15.8
V1508	2	13.2	9.1	9.1	14.2	14.9
V1506	6	6.9	4.7	4.7	7.3	7.4
J1408		0.59	0.4	0.4	0.64	0.68

SECTION IX

DIAGRAMS

9-1. WIRE CODE LEGEND.

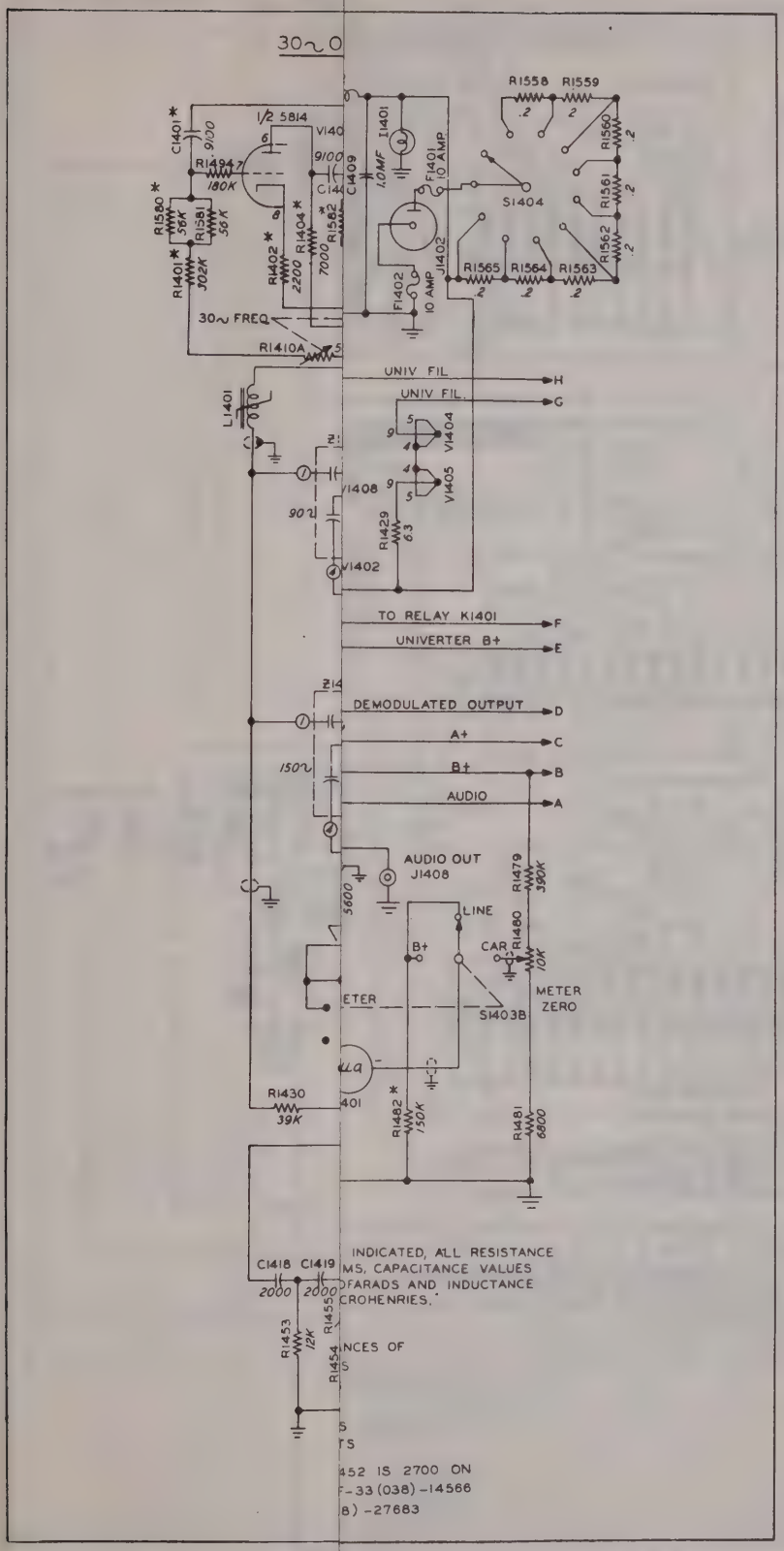
9-2. In the following diagrams, the designation on the various wires conforms to the following legend.



WIRE TYPE	
A	AN-J-C-48 WIRE
B	BUSBAR, ROUND TINNED COPPER
C	JAN TYPE WL (600 VOLTS)
D	MINIATURE JAN WIRE (PRODELIN)
R	JAN TYPE SRIR (1000 VOLTS)
V	JAN TYPE SRHV (2500 VOLTS)

WIRE SIZE	
A	NO 22 AWG
B	NO 20 AWG
C	NO 18 AWG
D	NO 16 AWG
E	NO 14 AWG
F	NO 12 AWG
G	NO 10 AWG
H	NO 8 AWG

COLOR	
0	BLACK
1	BROWN
2	RED
3	ORANGE
4	YELLOW
5	GREEN
6	BLUE
7	VIOLET-PURPLE
8	GRAY
9	WHITE



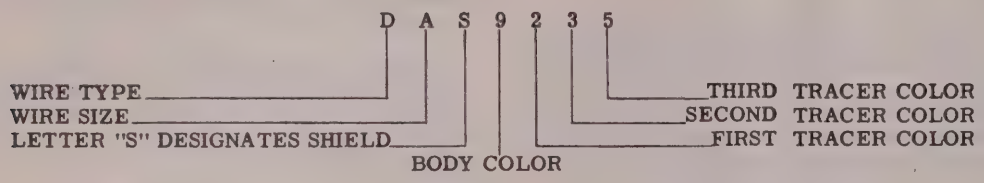
, Schematic Diagram,

SECTION IX

DIAGRAMS

9-1. WIRE CODE LEGEND.

9-2. In the following diagrams, the designation on the various wires conforms to the following legend.



WIRE TYPE	
A	AN-J-C-48 WIRE
B	BUSBAR, ROUND TINNED COPPER
C	JAN TYPE WL (600 VOLTS)
D	MINIATURE JAN WIRE (PRODELIN)
R	JAN TYPE SRIR (1000 VOLTS)
V	JAN TYPE SRHV (2500 VOLTS)

WIRE SIZE	
A	NO 22 AWG
B	NO 20 AWG
C	NO 18 AWG
D	NO 16 AWG
E	NO 14 AWG
F	NO 12 AWG
G	NO 10 AWG
H	NO 8 AWG

COLOR	
0	BLACK
1	BROWN
2	RED
3	ORANGE
4	YELLOW
5	GREEN
6	BLUE
7	VIOLET-PURPLE
8	GRAY
9	WHITE

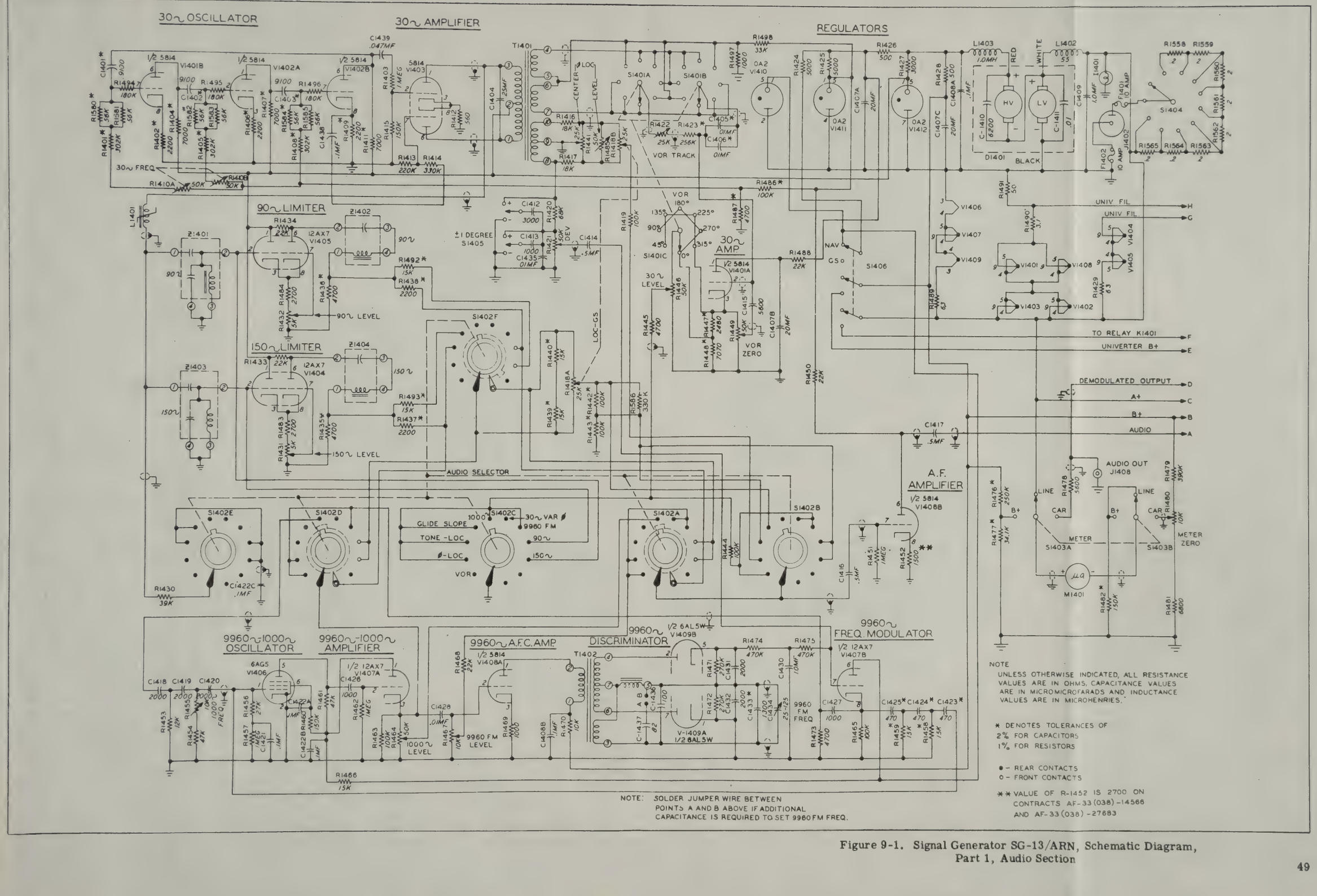
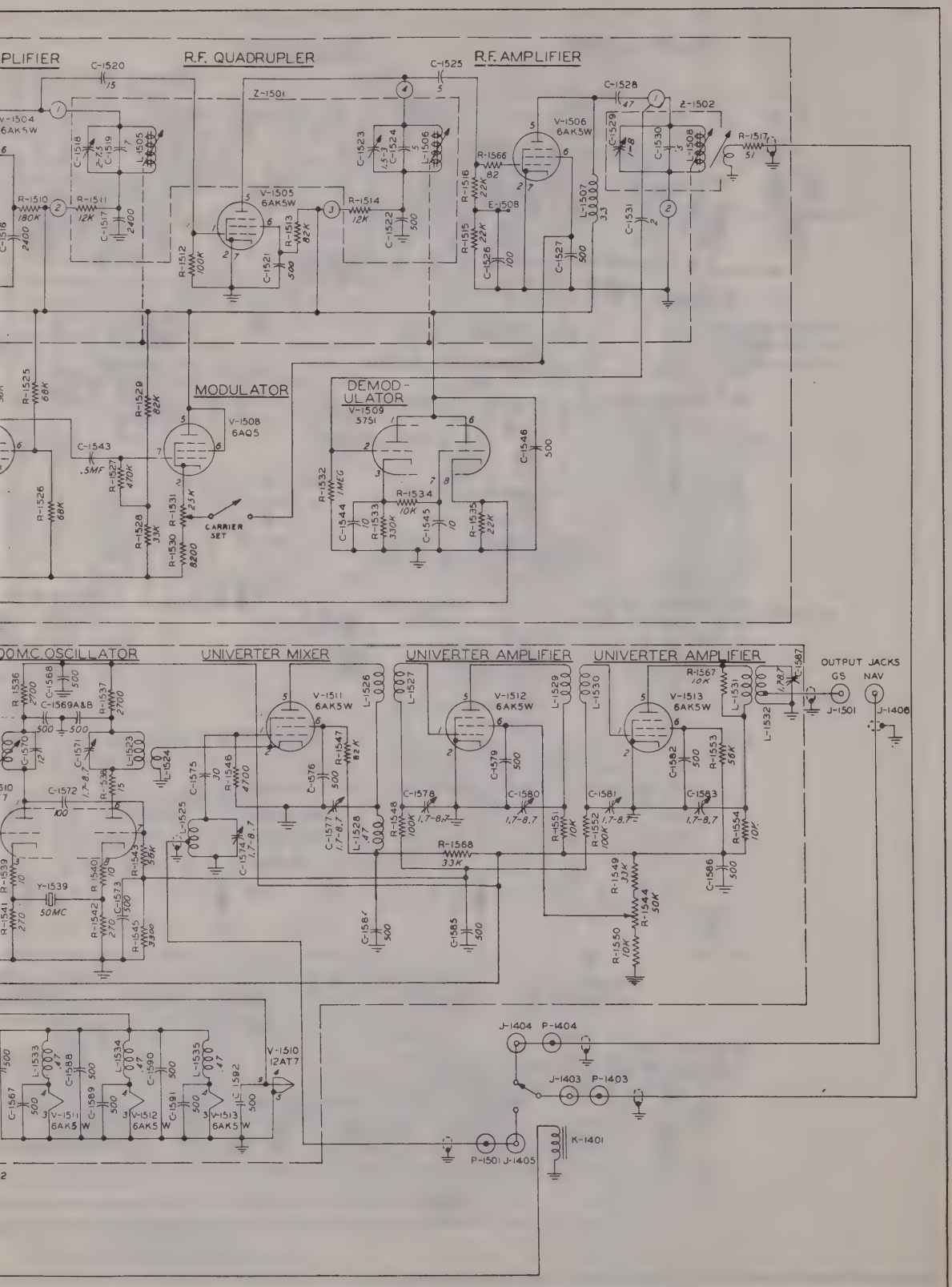


Figure 9-1. Signal Generator SG-13/ARN, Schematic Diagram, Part 1, Audio Section


PLIFIER
R.F. QUADRUPLER
R.F. AMPLIFIER
Z-1501
Z-1502
V-1504 6AK5W
V-1505 6AK5W
V-1506 6AK5W
MODULATOR
V-1508 6AQ5
DEMOD-ULATOR
V-1509 5751
CARRIER SET
OMC OSCILLATOR
UNIVERTER MIXER
UNIVERTER AMPLIFIER
UNIVERTER AMPLIFIER
V-1511 6AK5W
V-1512 6AK5W
V-1513 6AK5W
OUTPUT JACKS
GS
NAV
J-1501
J-1408
Y-1539
50MC
V-1510 12AT7
J-1404 P-1404
J-1403 P-1403
P-1501 J-1405
K-1401

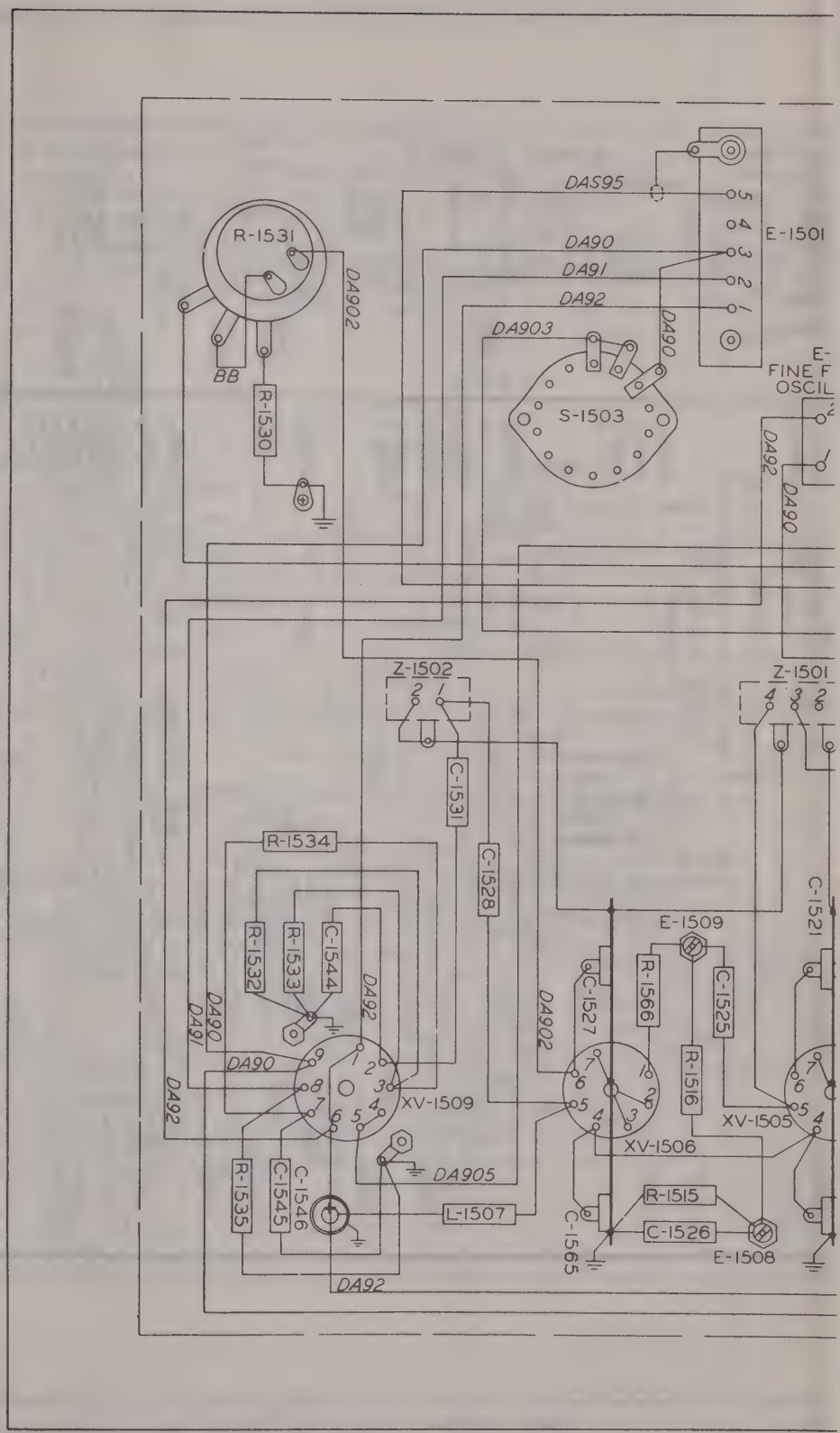


Figure 9-3. Signal Generator SG-13/ARN, R-F Section Practica Wiring Diagram

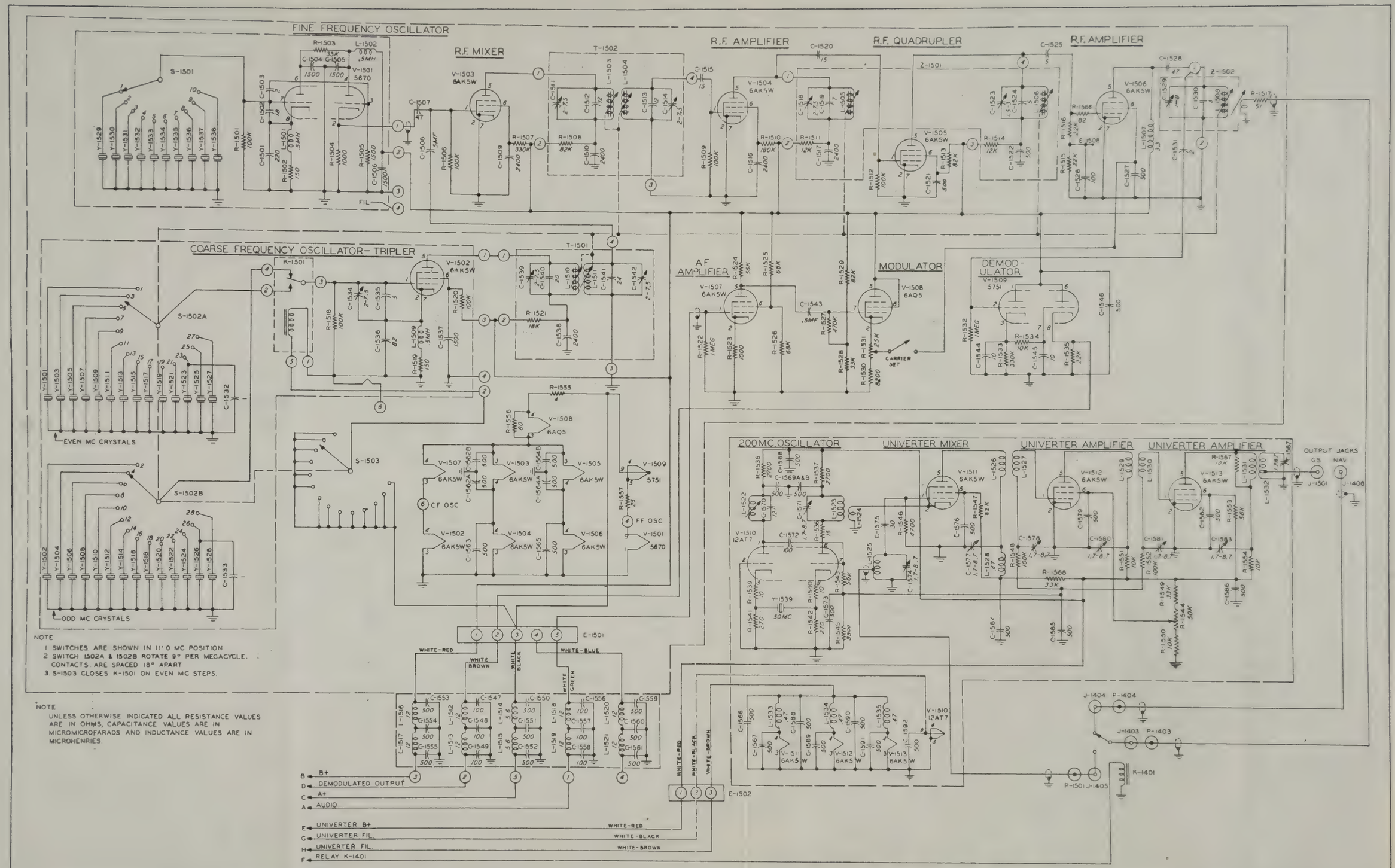


Figure 9-1. Signal Generator SG-13/ARN, Schematic Diagram, Part 2, R-F Section

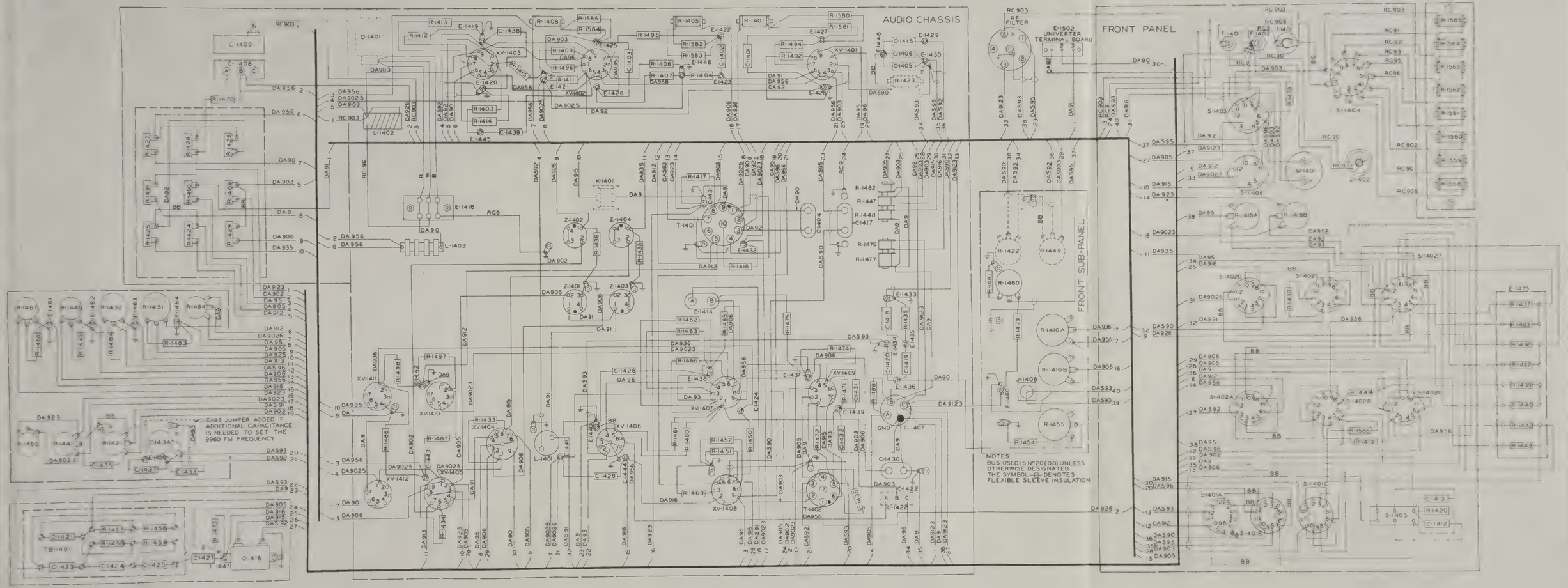
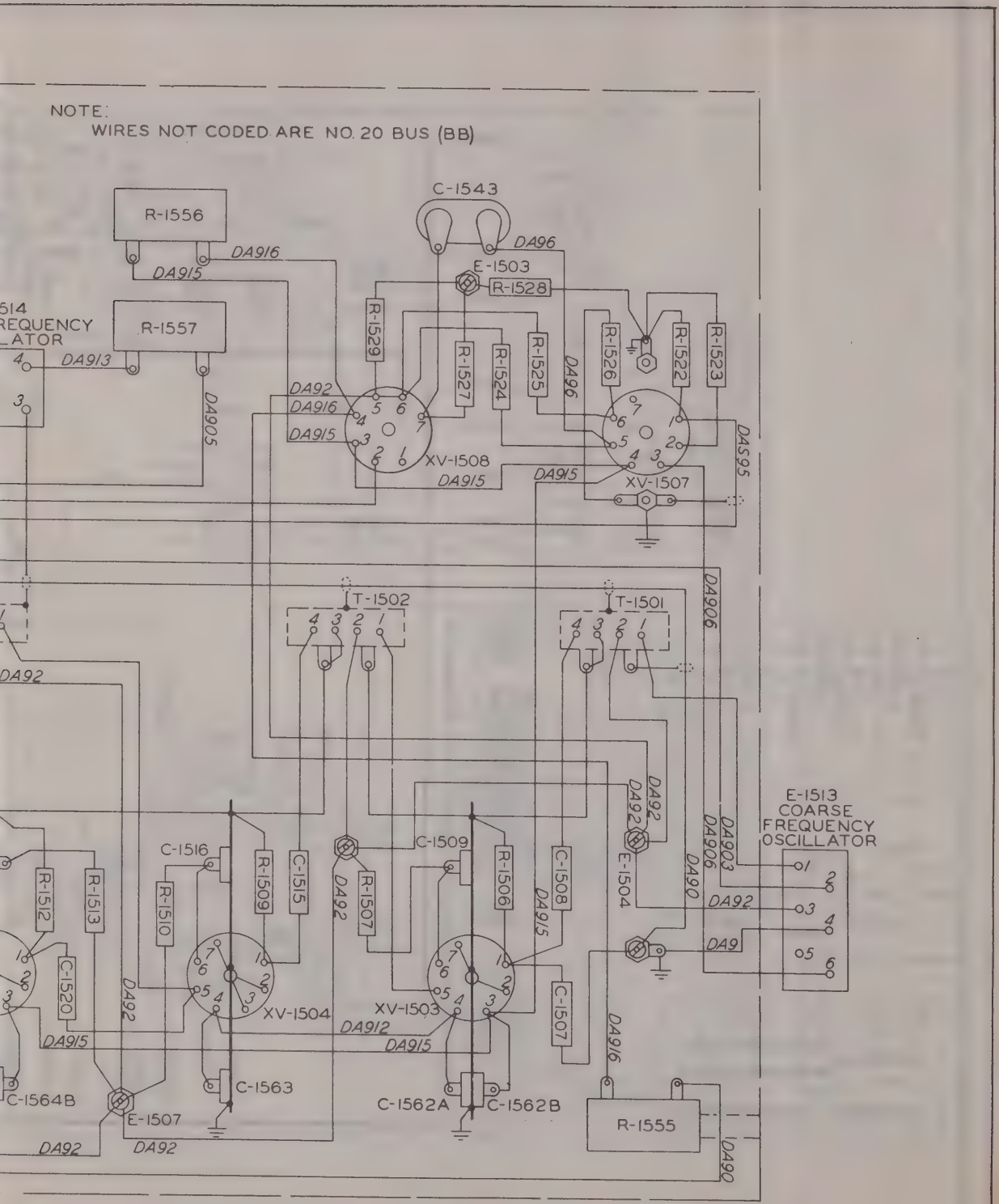


Figure 9-2. Signal Generator SG-13/ARN, Audio Section and Front Panel Practical Wiring Diagram


NOTE:
WIRES NOT CODED ARE NO. 20 BUS (BB)
R-1556
R-1557
DA916
DA915
DA913
DA905
C-1543
DA96
E-1503
R-1528
R-1529
R-1527
R-1524
R-1525
R-1526
R-1522
R-1523
DA92
DA916
DA915
XV-1508
DA915
DA915
XV-1507
DA995
T-1502
T-1501
DA906
DA92
DA92
DA92
E-1504
E-1513
COARSE
FREQUENCY
OSCILLATOR
DA903
DA906
DA90
DA92
DA9
C-1516
R-1509
C-1515
R-1510
R-1512
R-1513
C-1520
C-1509
R-1506
C-1508
R-1507
DA492
DA915
XV-1504
XV-1503
DA912
DA915
C-1507
DA916
C-1563
C-1564B
E-1507
C-1562A
C-1562B
R-1555
DA92
DA92
DA90

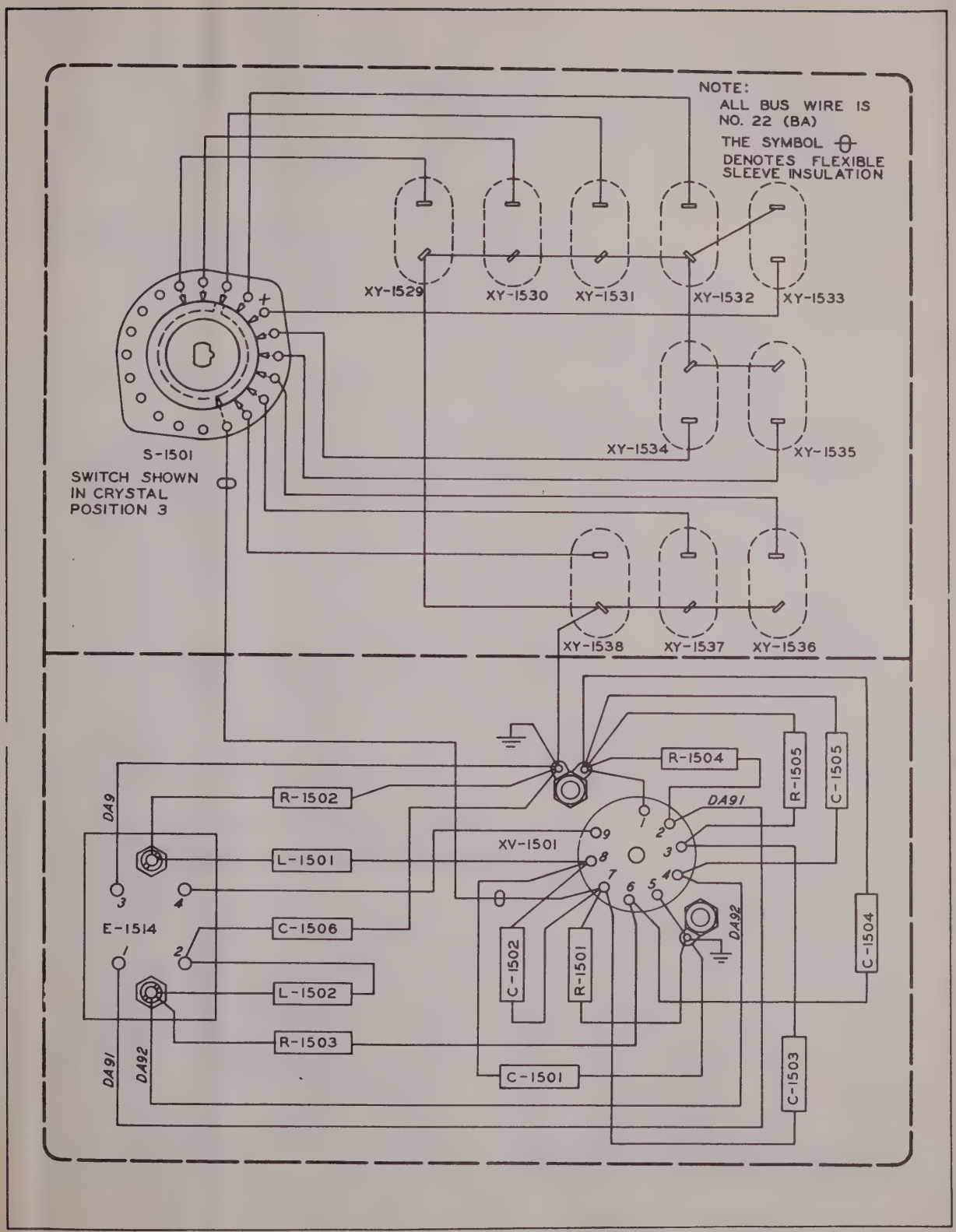


Figure 9-4. Signal Generator SG-13/ARN, Fine Frequency Oscillator Practical Wiring Diagram

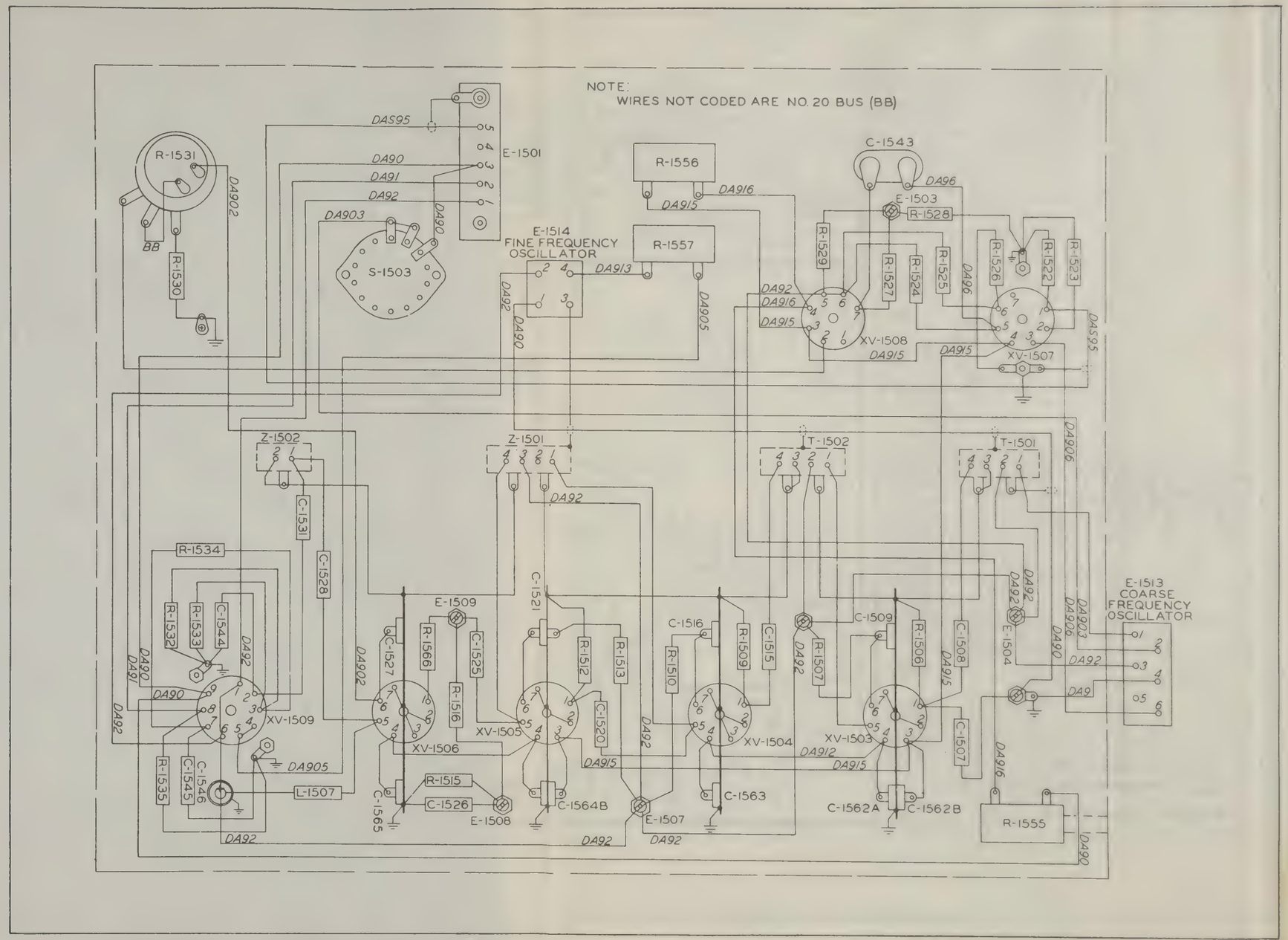
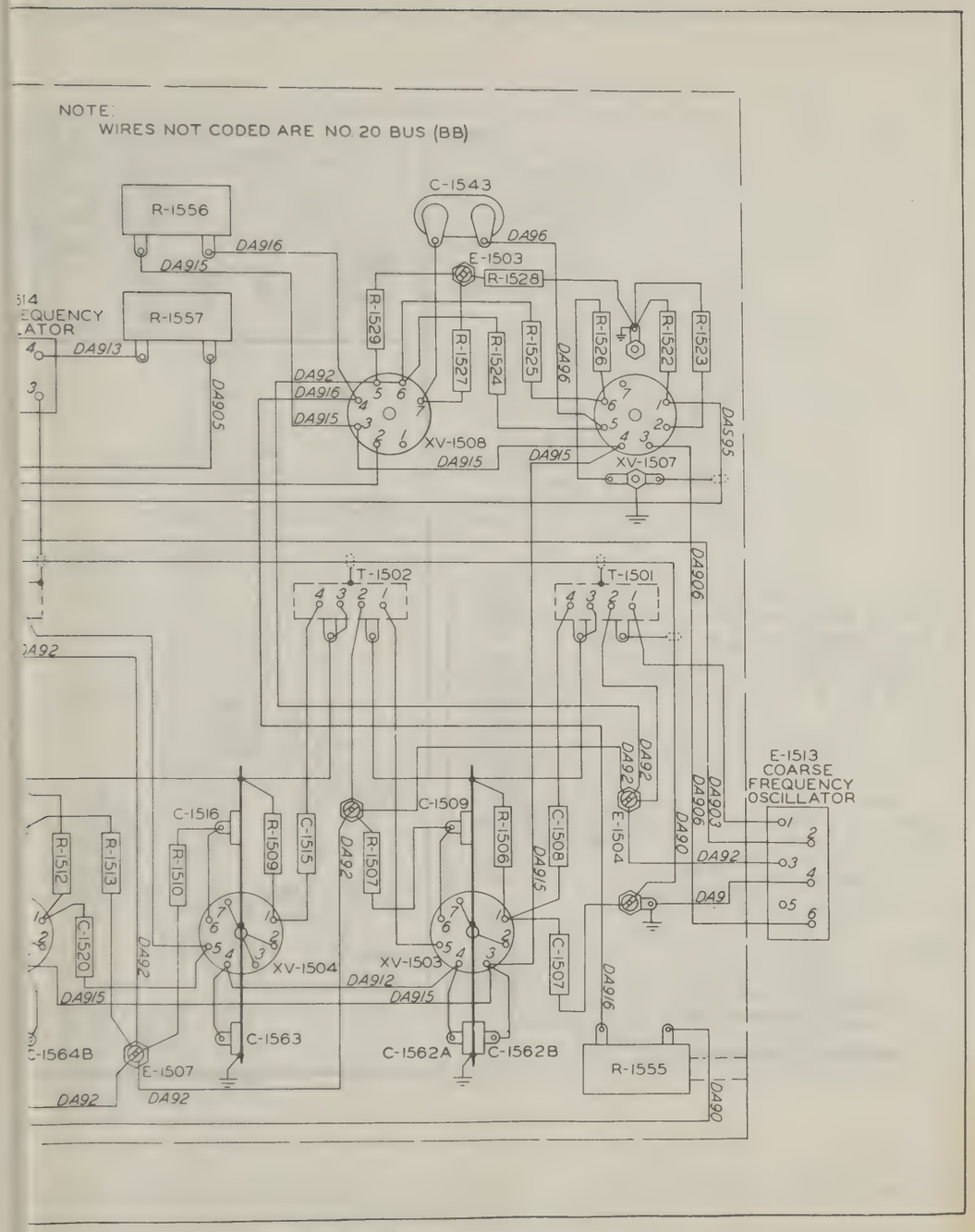


Figure 9-3. Signal Generator SG-13/ARN, R-F Section Practical Wiring Diagram



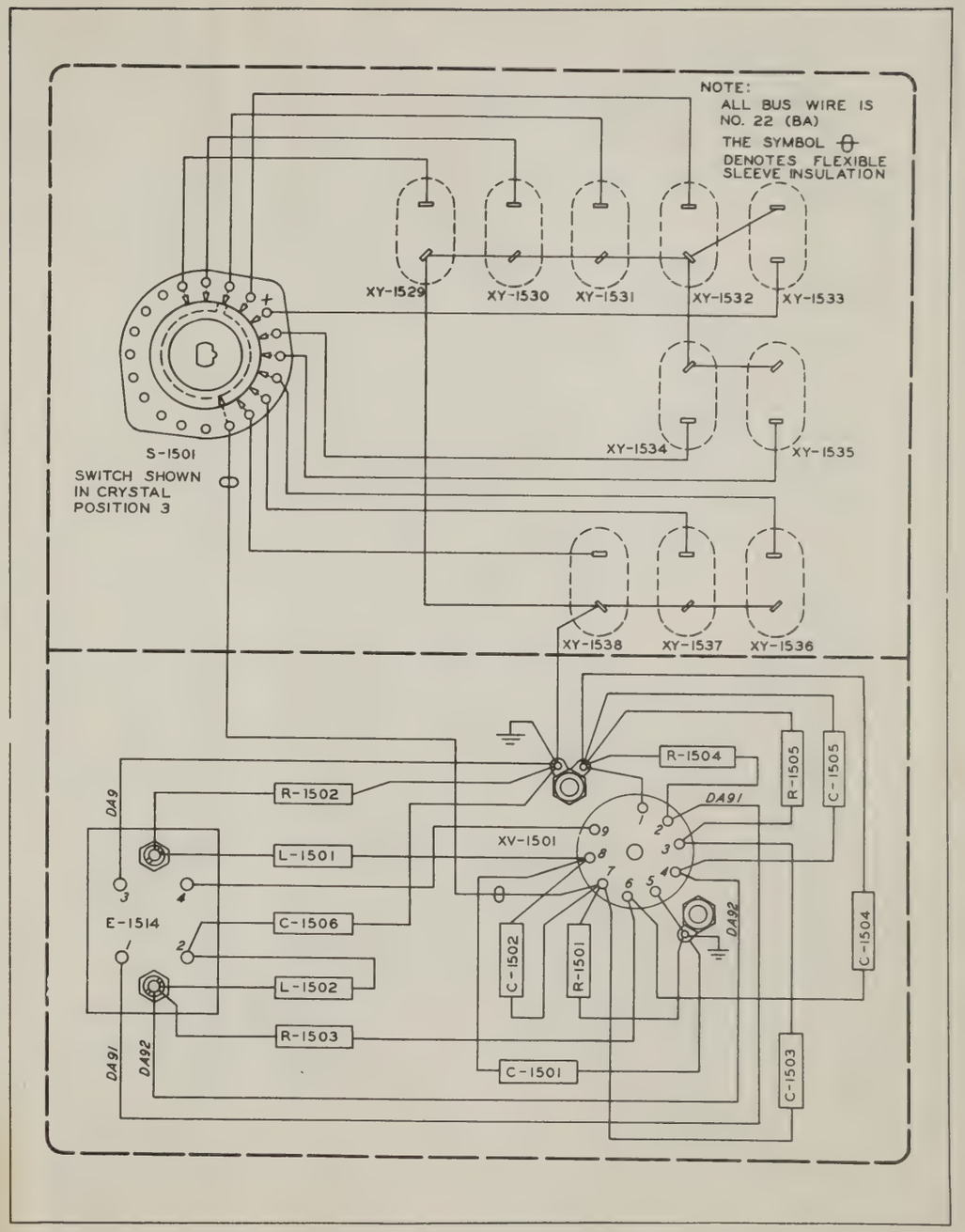


Figure 9-4. Signal Generator SG-13/ARN, Fine Frequency Oscillator Practical Wiring Diagram

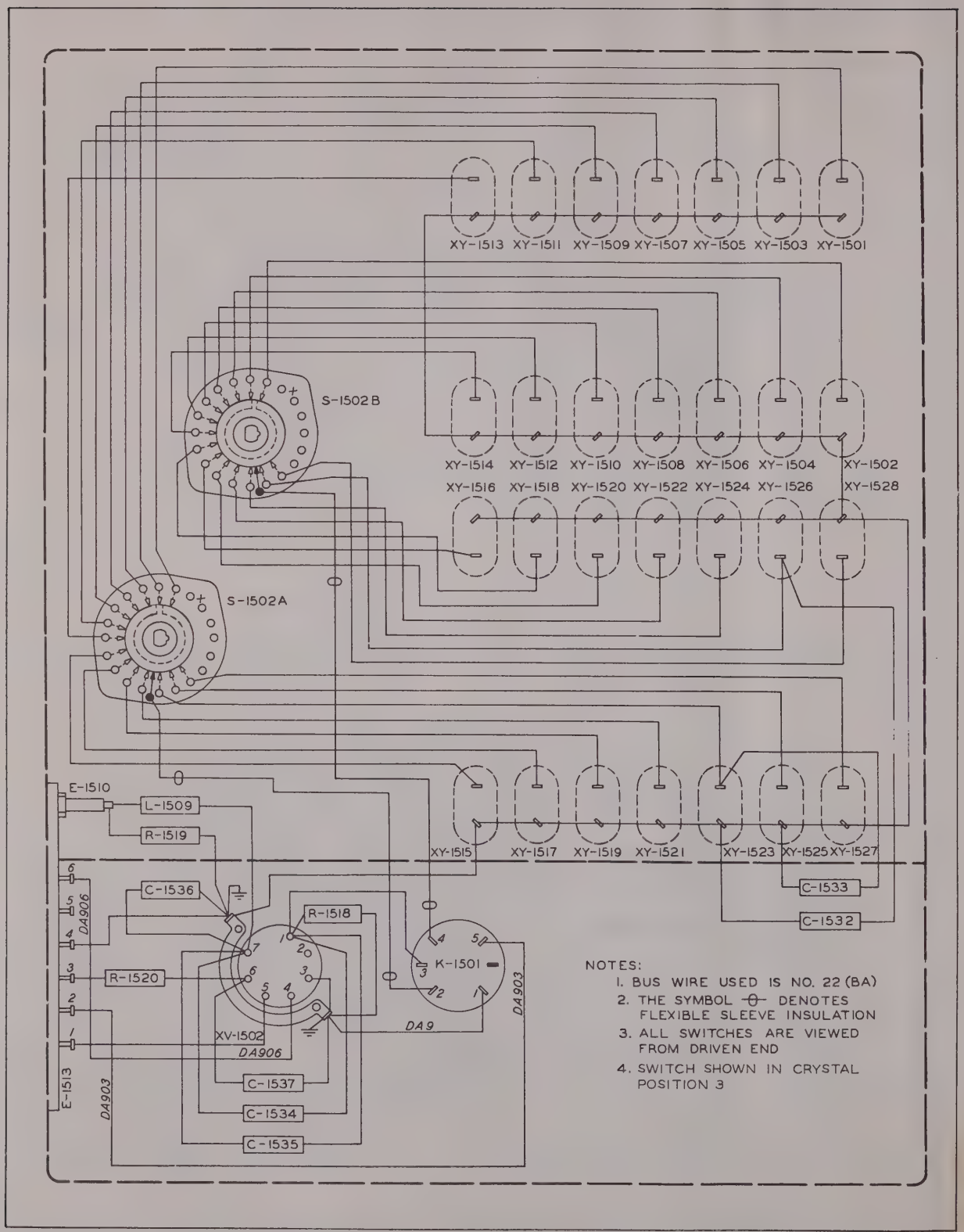
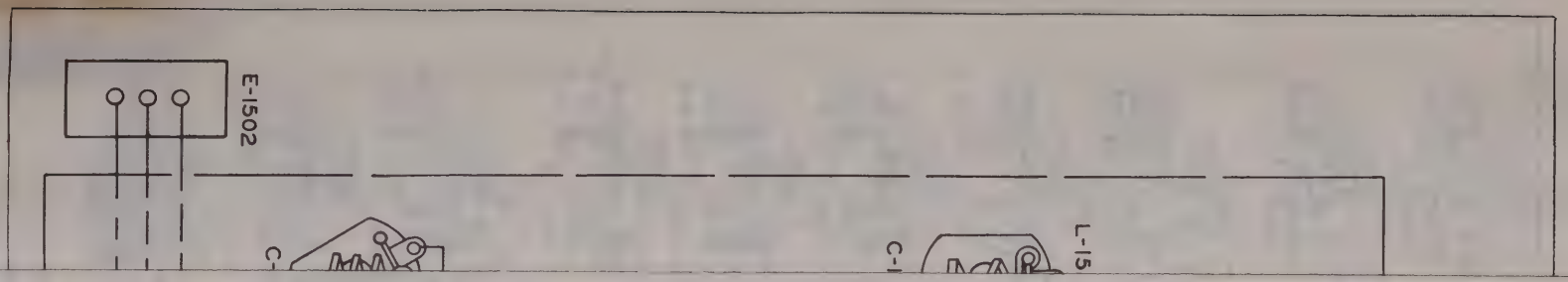


Figure 9-5. Signal Generator SG-13/ARN, Coarse Frequency Oscillator Practical Wiring Diagram


E-1502
L-15

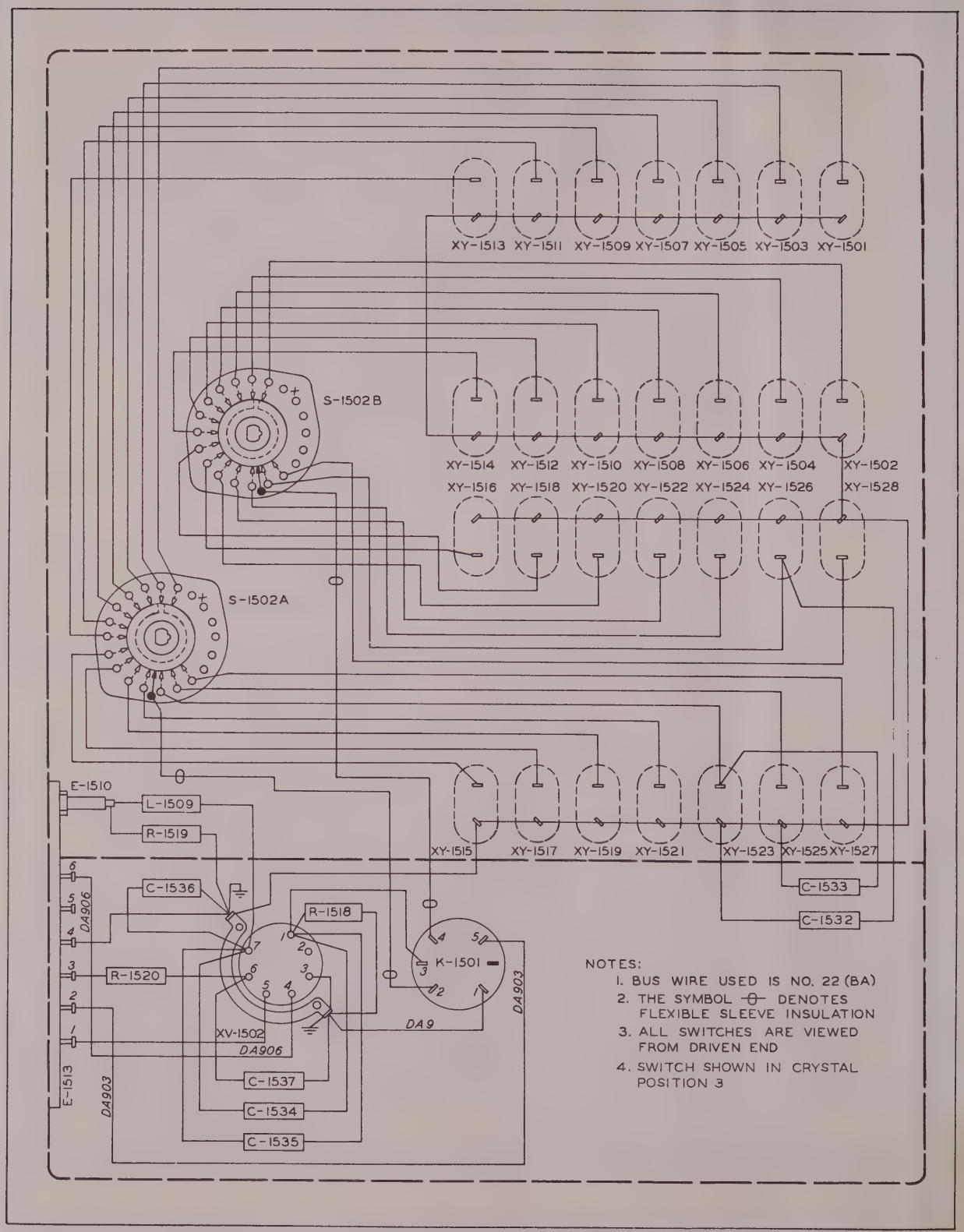


Figure 9-5. Signal Generator SG-13/ARN, Coarse Frequency Oscillator Practical Wiring Diagram

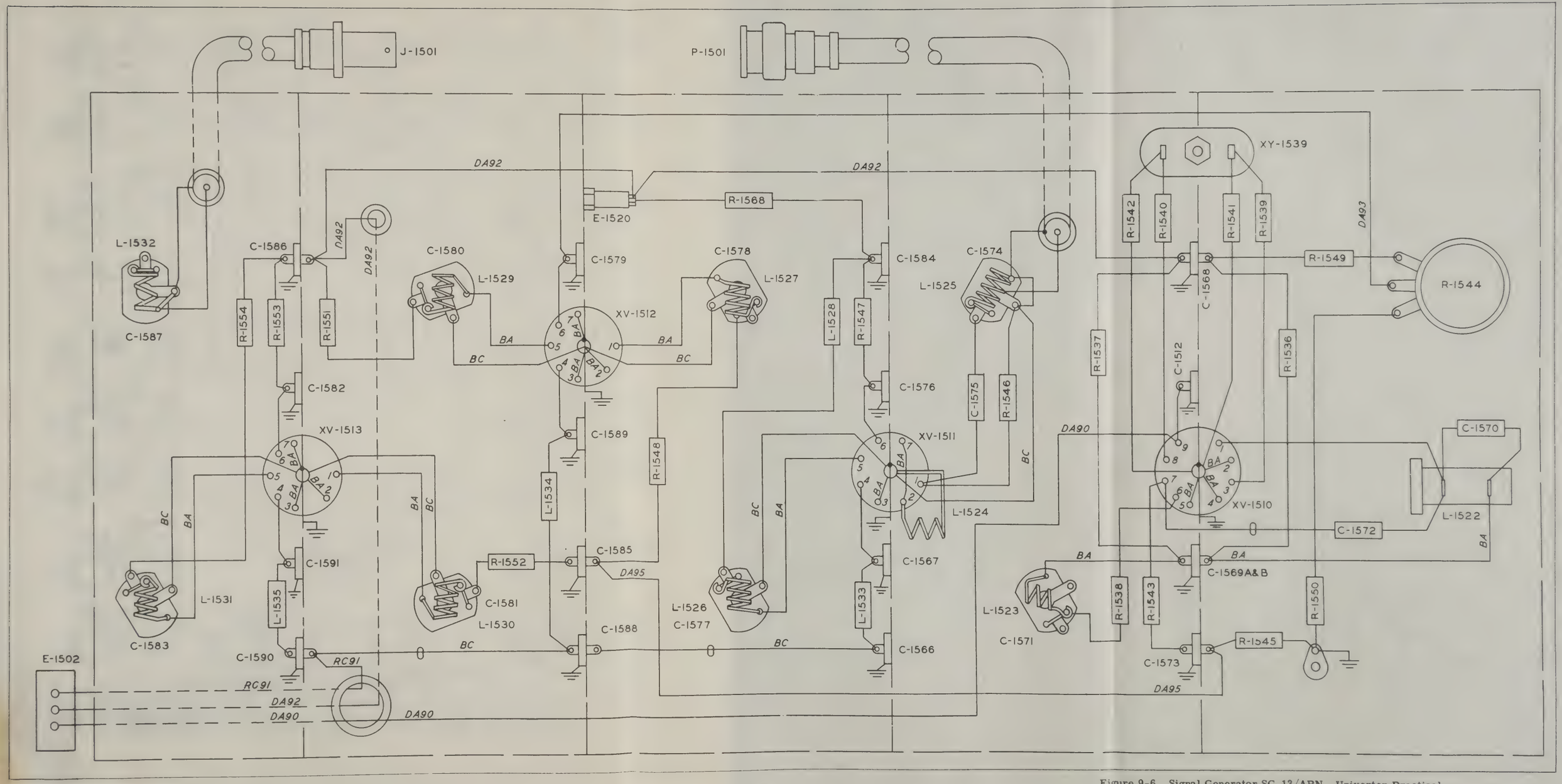
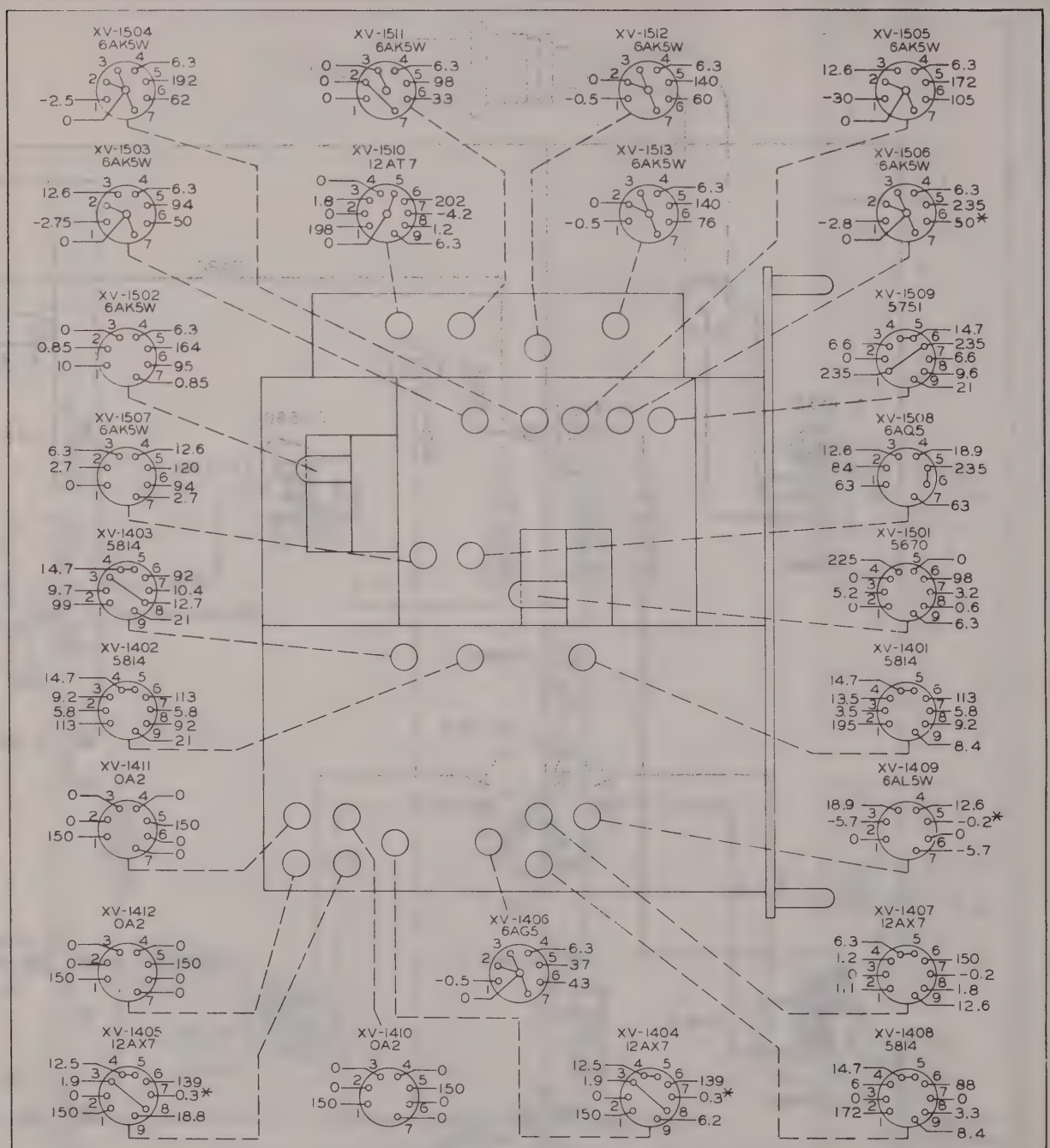
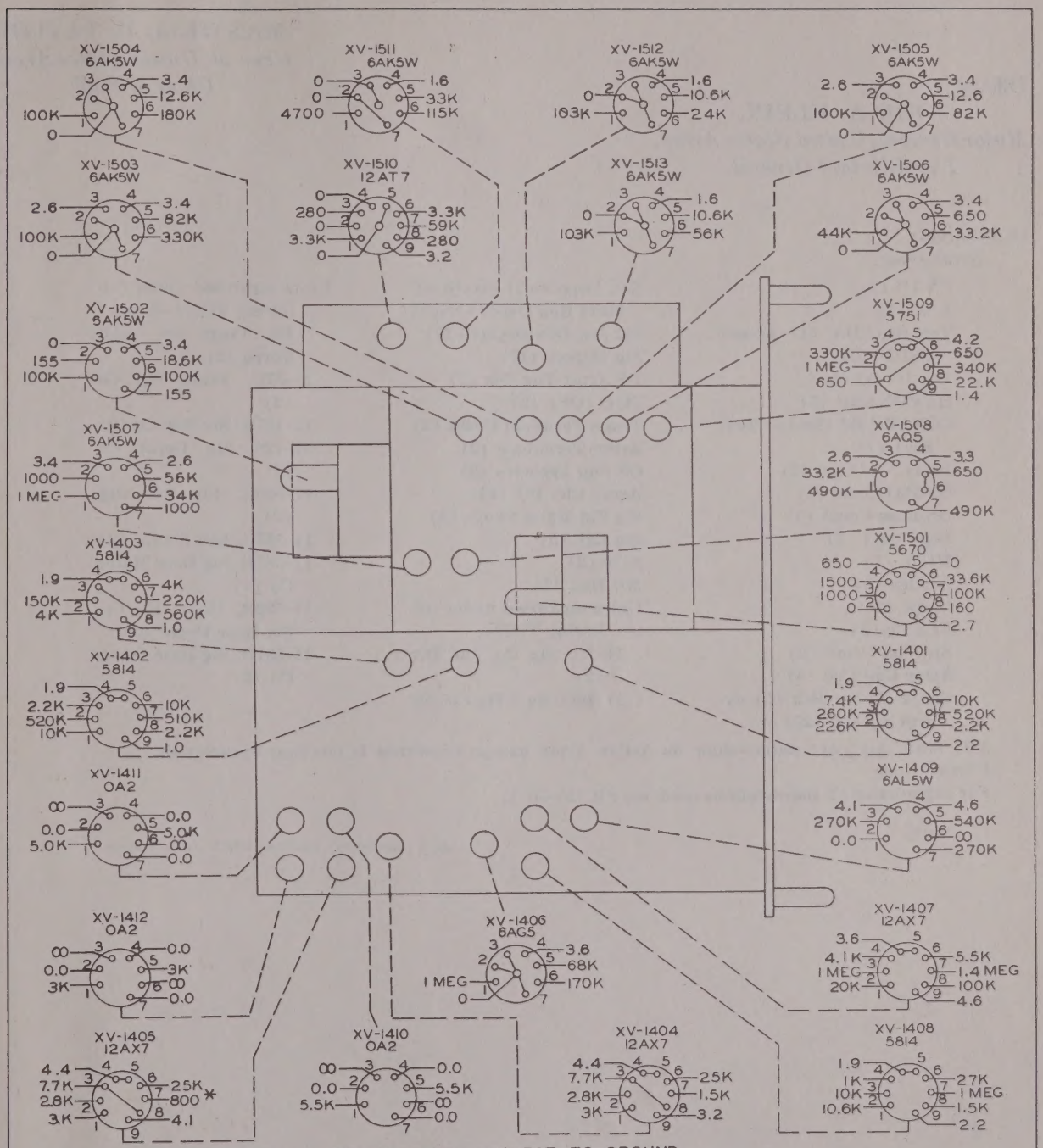


Figure 9-6. Signal Generator SG-13/ARN, Univerter Practical Wiring Diagram



NOTES: VOLTAGE POSITIVE UNLESS OTHERWISE INDICATED
MEASUREMENTS MADE WITH ELECTRONIC DESIGNS MODEL 100, VTVM.
LINE VOLTAGE SET TO 21V; VOR SWITCH ON 0°; LDC-GS CONTROL SET TO CENTER POSITION; METER SWITCH ON CAR POSITION; SET CARRIER ADJUSTED TO THE RED LINE. FOR MEASUREMENTS ON V-1401 THROUGH V-1509: NAV-GS SWITCH SET ON NAV; MEGACYCLES CONTROL SET ON 114.9; AUDIO SELECTOR ON VOR. FOR MEASUREMENTS ON V-1510 THROUGH V-1513: NAV-GS SWITCH SET ON GS; MEGACYCLES CONTROL SET ON 332.0 AUDIO SELECTOR ON GLIDE SLOPE.
* THIS READING MAY VARY CONSIDERABLY BETWEEN UNITS.

Figure 9-7. Signal Generator SG-13/ARN D-C Voltage Measurement Diagram



NOTES: ALL READING WITH RESPECT TO GROUND.
MEASUREMENTS MADE WITH ELECTRONIC DESIGNS MODEL 100, VTVM. LINE SWITCH TO OFF POSITION; VOR SWITCH ON 0°; LOC-GS CONTROL SET TO CENTER POSITION; METER SWITCH ON LINE POSITION; SET CARRIER TURNED TO MAXIMUM CLOCKWISE POSITION. FOR MEASUREMENTS ON V-1401 THROUGH V-1509: NAV-GS SWITCH ON NAV; MEGACYCLES CONTROL SET ON 114.9; AUDIO SELECTOR ON VOR. FOR MEASUREMENTS ON V-1510 THROUGH V-1513: NAV-GS SWITCH ON GS; MEGACYCLES CONTROL SET ON 332.0; AUDIO SELECTOR ON GLIDE SLOPE.
* THIS READING MAY VARY CONSIDERABLY BETWEEN UNITS.

Figure 9-8. Signal Generator SG-13/ARN, Resistance Measurement Diagram

By Order of *Wilber M. Brucker*, Secretary of the Army:

MAXWELL D. TAYLOR,
General, United States Army,
Chief of Staff.

Official:

JOHN A. KLEIN,
Major General, United States Army,
The Adjutant General.

Distribution:

Active Army:

CNGB (1)
ASA (3)
Tec Svc, DA (1) except CSIGO (30)
Tec Svc Bd (1)
Hq CONARC (5)
CONARC Bd (Incl ea Test Sec) (1)
Army AA Comd (2)
OS Maj Comd (5)
OS Base Comd (5)
Log Comd (5)
MDW (1)
Armies (5)
Corps (2)
Ft & Cp (2)
Sp Wpn Comd (2)
Army Cml Cen (4)
Gen & Br Svc Sch (5) except Sig Sch (25)
Gen Depots (2) except Atlanta Gen Depot (None)
Sig Sec, Gen Depots (10)
Sig Depots (17)
US Army Tng Cen (2)
POE (OS) (2)
Trans Terminal Comd (2)
Army Terminals (2)
OS Sup Agencies (2)
Army Elct PG (1)
Sig Fld Maint Shops (3)
Sig Lab (5)
ACS (3)
Mil Dist (1)
Units organized under following TOE's:
11–7C, Sig Co, Inf Div (2)
11–16C, Hq & Hq Co, Sig Bn, Corps or Abn Corps (2)
11–57C, Armd Sig Co (2)
11–127R, Sig Rep Co (2)
11–128, Sig Depot Co (2)
11–500R, Sig Svc Org (2)
11–557C, Abn Sig Co (2)
11–587R, Sig Base Maint Co (2)
11–592R, Hq & Hq Co, Sig Base Depot (2)
11–597R, Sig Base Depot Co (2)

NG: State AG (6); units—same as Active Army except allowance is one copy to each unit.
USAR: None.
For explanation of abbreviations used, see SR 320–50–1.

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